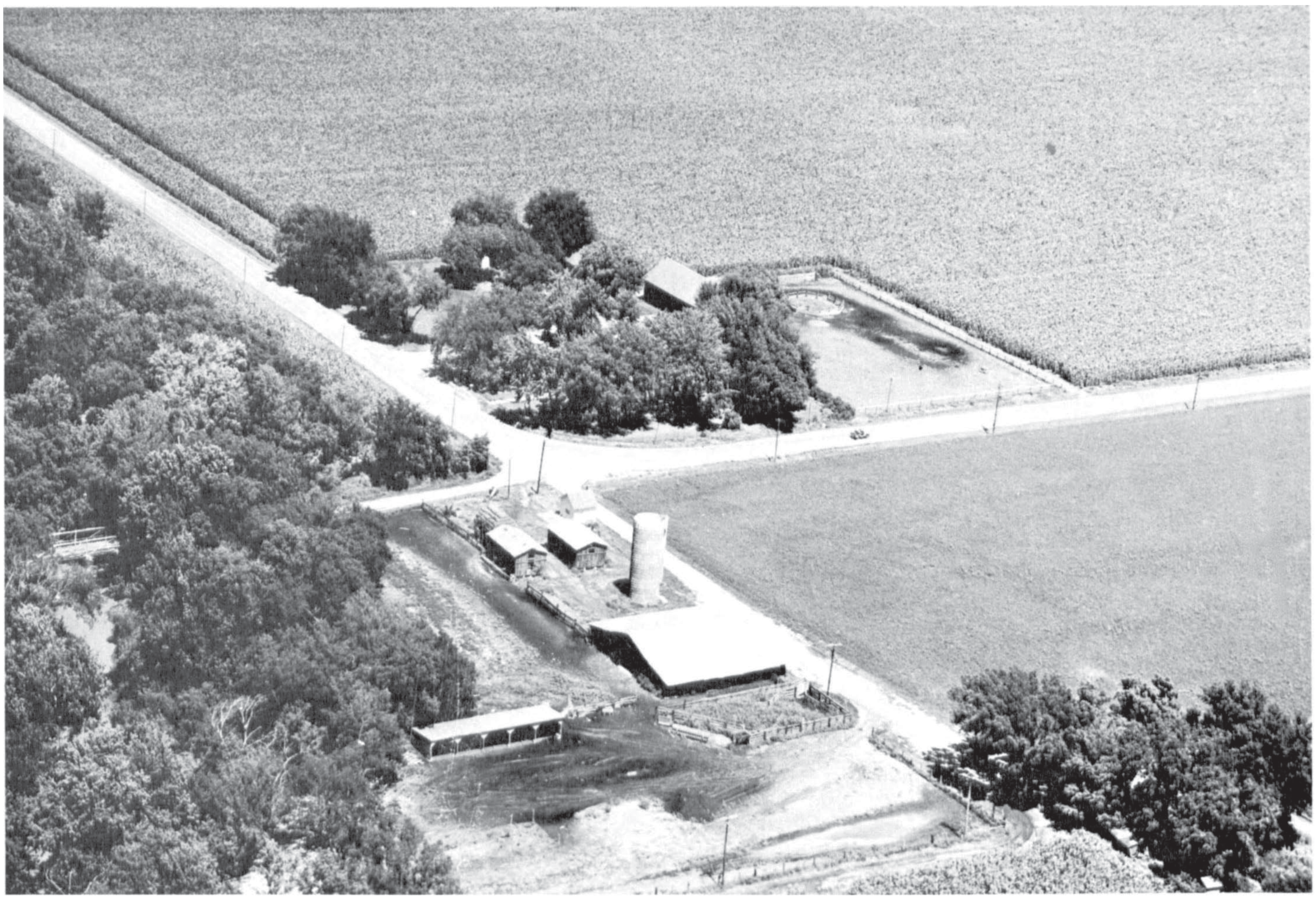
Issued June 1970

SOIL SURVEY

Shawnee County, Kansas



UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
in cooperation with
KANSAS AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1956–65. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1965. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station; it is part of the technical assistance furnished to the Shawnee County Soil Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or can be purchased on individual order, from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Shawnee County contains information that can be applied in managing farms, woodlands, and grazing lands; in selecting sites for roads, ponds, buildings, or other structures; and in judging the suitability of tracts of land for agriculture, industry, or recreation.

Locating Soils

All of the soils of Shawnee County are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, woodland suitability group, range site, or any other group in which the soil has been placed.

Interpretations not included in the text can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the discussions of the capability units, range sites, and woodland suitability groups.

Foresters and others can refer to the section "Woodland Management," where the soils of the county are grouped according to their suitability for windbreaks and trees.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Wildlife Management."

Ranchers and others interested in range can find under "Range Management" groupings of the soils according to their suitability for range and also the plants that grow on each range site.

Community planners and others concerned with recreational development can read about the soil properties that affect the choice of sites for parks, picnic areas, and other recreational uses in the section "Use of Soils for Recreational Sites."

Engineers and builders will find under "Engineering Uses of Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Shawnee County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About the County."

***Cover picture:* Irrigated farm on Muir soils in the valley of the Kansas River. The crop in background is corn that in most years produces more than 125 bushels per acre.**

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Contents

Issued June 1970

SOIL SURVEY OF SHAWNEE COUNTY, KANSAS

BY WALTER ABMEYER AND HOWARD V. CAMPBELL, SOIL CONSERVATION SERVICE,[1] UNITED STATES DEPARTMENT OF AGRICULTURE, IN COOPERATION WITH THE KANSAS AGRICULTURAL EXPERIMENT STATION

SHAWNEE COUNTY, in the northeastern part of Kansas, covers a total area of 545 square miles, or 348,800 acres (fig. 1). Topeka, in the east-central part of the county along the Kansas River, is the county seat and State capital.

Farming is an important enterprise in the county. Corn, wheat, grain, and forage sorghum, soybeans, and alfalfa are the main crops. Some truck crops and nursery stock are grown along the valley of the Kansas River. Beef cattle are the main kind of livestock in the county, though some milk cows are kept for dairy products. Raising of sheep and poultry is also important.

Irrigation is practiced by many farmers in the valley of the Kansas River, where water of good quality is abundant.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Shawnee County, where they are located, and how they can be used. The soil scientists went into the survey area knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Wabash and Shelby, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural landscape.

Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Shelby clay loam, 3 to 8 percent slopes, is one of several phases within the Shelby series.

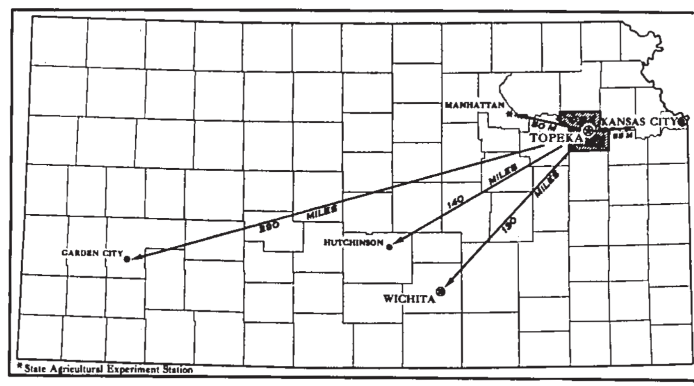

Figure 1.—Location of Shawnee County in Kansas.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that greatly help in drawing soil boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. A soil complex consists of two or more soils so intricately mixed

[1] HAROLD P. DICKEY and RICHARD D. DAVIS, soil scientists, Soil Conservation Service, assisted in the survey of the bottom lands along the Kansas River.

or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of two or more dominant soils, and the pattern of and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Eudora-Kimo complex is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types instead of soils and are given descriptive names. Broken alluvial land and Stony steep land are examples of two land types in Shawnee County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, managers of woodland, engineers, and homeowners.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, and then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Shawnee County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, or selection of a site for a large building, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The eight soil associations in the county are described in the following paragraphs.

1. Reading-Wabash Association

Deep, well-drained to somewhat poorly drained soils that have a silty clay loam or silty clay subsoil; on flood plains and low terraces

This association occupies the alluvial plains of most tributary streams of the Kansas River and is also in the backwater areas near the outer edges of the valley of the Kansas River. This association covers about 10 percent of the county.

The Reading soils make up about 50 percent of this association; Wabash soils, 33 percent; and minor soils, the remaining 17 percent.

The Reading soils occur on high bottoms and low terraces and are nearly level and well drained. They have a surface layer of dark grayish-brown silty clay loam about 14 inches thick. The subsoil is also silty clay loam, but it is dark brown and brown and is about 42 inches thick. The underlying material is yellowish-brown silty clay loam.

The Wabash soils are nearly level and are moderately well drained to somewhat poorly drained. They occur in the backwater areas of the high bottoms and low terraces. In Wabash soils dark-gray silty clay extends from the surface to a depth of 60 inches and is underlain by gray silty clay.

Minor soils in this association are the Kennebec soils and Broken alluvial land. Kennebec soils are on bottom lands and are nearly level. Broken alluvial land consists of the channel and steep and very steep banks of perennial streams.

Most of this association is cultivated. The major soils are suited to all crops commonly grown in the county. Broken alluvial land is not arable, and most of it is wooded. Some small isolated areas of arable soils are also in trees. The main concerns in managing this association are slow drainage and the flooding of local areas.

2. Eudora-Muir Association

Deep, well-drained soils that have a loam to silty clay loam subsoil; on benches in the Kansas River Valley

This association occupies the alluvial plain adjacent to the Kansas River. It consists of nearly level soils that are interrupted by a few abandoned stream channels and by escarpments between various levels in the valley. This association covers about 12 percent of the county.

The Eudora soils make up about 33 percent of this association; Muir soils, 25 percent; and minor soils, the remaining 42 percent.

The Eudora soils occur mostly on intermediate levels in the valley and are above ordinary overflow of the Kansas River. Eudora soils are nearly level, well drained, light, and loamy. Their surface layer is grayish-brown silt loam about 12 inches thick. It is underlain by coarse loam or silt loam to a depth of about 42 inches. Below this the material is stratified coarse silt loam to fine sand.

Muir soils occupy intermediate and high levels of the river valley. They have a smooth surface and are nearly level and well drained. Their surface layer is dark-gray silt loam about 8 inches thick. The subsoil, about 54

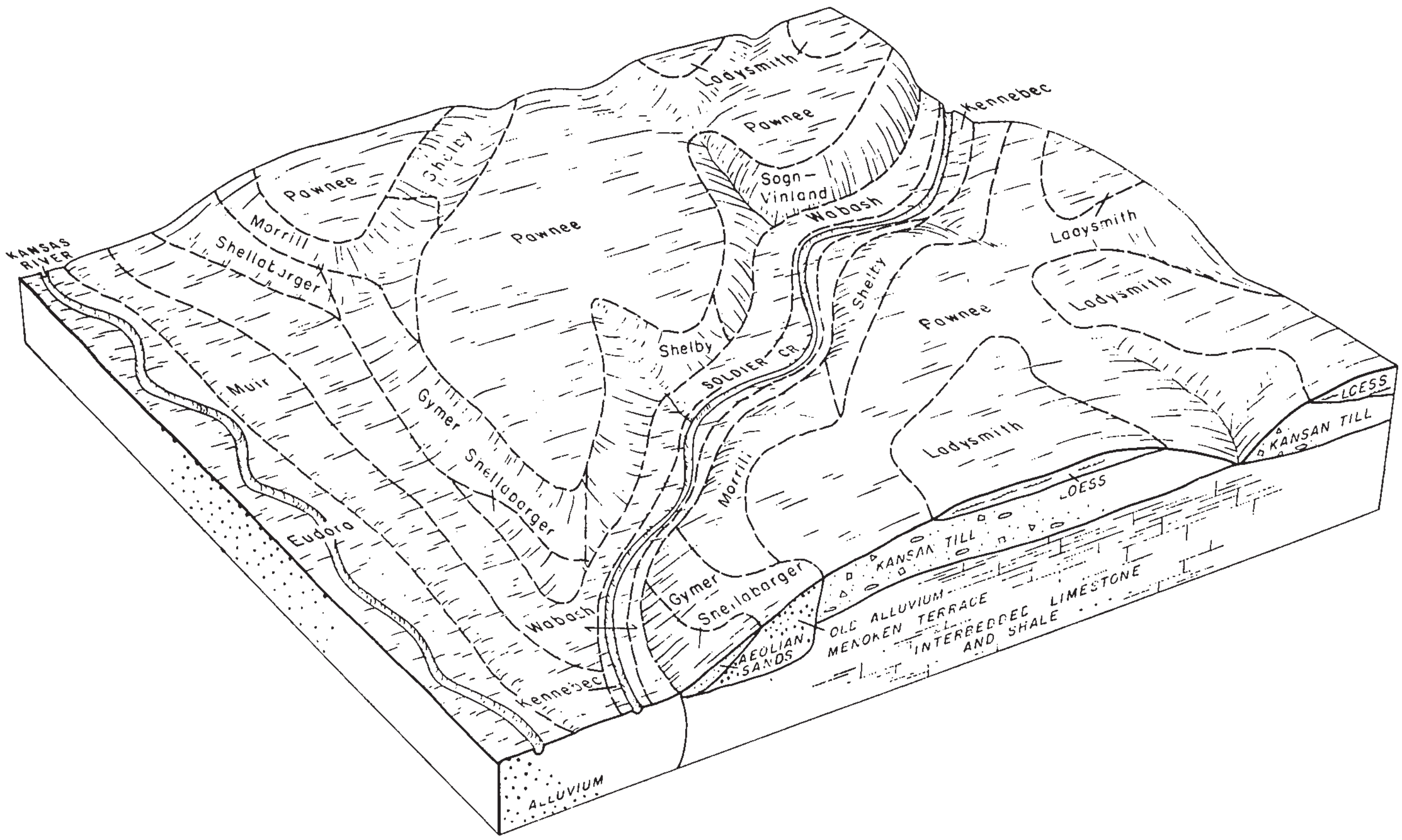

Figure 2.—**Loess-till area in the northern part of Shawnee County showing the relation of soils to the landscape in soil association 3.**

inches thick, is silt loam to a depth of 20 inches and is silty clay loam below that depth.

The rest of the association consists mainly of terrace escarpments and Kimo and Eudora soils that are closely intermingled with Sarpy and other soils.

Except in residential and industrial areas, nearly all the acreage of arable soils in this association is cultivated. The soils are suited to all crops commonly grown in the county, including truck crops and nursery stock. Soil blowing may occur in winter and early in spring. Streambanks and other nonarable sites are generally covered by trees. Unless protected by levees, low areas of Kimo, Sarpy, and Eudora soils are occasionally flooded. At intermediate and high levels, however, these soils are affected only by major floods, such as occurred in 1951.

3. Pawnee-Shelby-Morrill Association

Deep, well drained and moderately well drained, gently sloping to strongly sloping soils that have a clay or clay loam subsoil; on uplands

This association occupies most of the area north of the Kansas River (fig. 2) consisting of gently sloping to strongly sloping soils. It also includes a large part of the city of Topeka. This association makes up about 23 percent of the county.

The Pawnee soils occupy about 70 percent of the association; Shelby soils, 12 percent; Morrill soils, 11 percent; and minor soils, the remaining 7 percent.

The Pawnee soils occur on uplands and are moderately well drained and medium acid. Slopes range from 1 to 11 percent but are generally between 3 and 7 percent. These soils have a surface layer of dark-colored, medium acid clay loam about 12 inches thick. The subsoil is very dark grayish brown clay loam in the upper part. The lower part is clay that extends to a depth of 48 inches.

The Shelby and Morrill soils are well drained and medium acid. They generally occupy lower slopes and receive runoff water from soils upslope. Shelby soils have a clay loam surface layer that is about 12 inches thick and that overlies a brownish clay loam subsoil. The lower part of the subsoil contains a few iron-manganese concretions. Morrill soils have a clay loam surface layer 9 inches thick. The subsoil, about 30 inches thick, is reddish-brown clay loam that grades to yellowish-red gritty clay loam in the lower part. Shelby and Morrill soils are underlain by clay loam or tight clay.

Minor soils in this association are the Kennebec, Reading, and Martin. The Kennebec and Reading soils are along drains, and Martin soils are on uplands.

Most of the acreage is cultivated and is suited to all crops commonly grown in the county. Areas not cultivated are used for pasture or range. Controlling erosion is the major concern where this association is cultivated.

4. Ladysmith-Pawnee Association

Deep, moderately well drained, nearly level and gently sloping soils that have a silty clay or clay subsoil; on uplands

This association consists of soils on broad ridges and of gently sloping soils on side slopes. One large area extends to the south and southeast of Topeka, one area is in the western part of the county, and small areas are north of the Kansas River. This association covers about 9 percent of the county.

The Ladysmith soils make up about 56 percent of this association; Pawnee soils, 28 percent; and minor soils, the remaining 16 percent.

The Ladysmith soils occur on ridgetops, are nearly level to gently sloping, and are moderately well drained. Their surface layer is silty clay loam about 10 inches thick. The subsoil, about 38 inches thick, is silty clay that is coated with clay films in the upper part. The underlying material is a gray silty clay mottled with strong brown.

The Pawnee soils are moderately well drained. They occur on side slopes and are gently sloping to sloping. These soils have a clay loam surface layer about 12 inches thick. It is underlain by a dense clay subsoil. The underlying material is clay mottled with light olive brown.

Also in this association are the minor Martin, Shelby, and Morrill soils and soils in broken areas around natural drainageways. These soils are on uplands.

Most of this association is cultivated and is suited to all crops commonly grown in the county. Uncultivated areas are in pasture or range. Controlling erosion and maintaining soil tilth and fertility are the main concerns in managing the cultivated areas.

5. Martin-Pawnee-Labette Association

Deep and moderately deep, well drained and moderately well drained, sloping to strongly sloping soils that have a silty clay or clay subsoil; on uplands

This association is composed of loamy, medium acid to slightly acid soils that are sloping and strongly sloping. These soils are on uplands in the southeastern part of the county. Limestone and shale crop out in a few places, and areas are broken around drainageways. Near the rock outcrops the soils are generally steep. This association covers about 6 percent of the county.

In this association Martin soils make up about 29 percent of the total acreage; Pawnee soils, 28 percent; Labette soils, 11 percent; and minor soils, the remaining 32 percent.

Martin soils are deep, dark-colored, moderately well drained soils that formed in material weathered from shale. Commonly, they are sloping and strongly sloping and occur in areas below limestone outcrops. They receive runoff from the soils upslope. Their surface layer is dark-gray silty clay loam about 12 inches thick. The subsoil, about 20 inches thick, is silty clay mottled with reddish brown to a depth of 36 inches. The underlying material is also silty clay, but it is mottled with strong brown and yellowish brown.

Pawnee soils are deep, medium acid, moderately well drained soils developed in glacial material. They occupy areas above and below rock outcrops. Pawnee soils have a surface layer of very dark grayish-brown clay loam about 12 inches thick. The subsoil, about 36 inches thick, generally is clay loam in the upper part. In the lower part it is brownish clay that extends to a depth of 48 inches.

Labette soils are deep and moderately deep, well-drained soils overlying limestone. Their surface layer is very dark grayish-brown silty clay loam about 13 inches thick. The subsoil, about 30 inches thick, is brownish silty clay.

About 20 percent of the association is made up of Sogn, Vinland, Elmont, and Sibleyville soils. These soils are sloping to steep. Also in this association are a few broken areas around natural drainageways and small areas of Morrill soils that formed in friable glacial material.

About 60 percent of the acreage in this association is cultivated; the rest is mostly in pasture and range, though some hardwood trees grow along the drainageways and on steep soils. The arable soils in this association are suited to crops commonly grown in the county. In cultivated areas measures are needed for controlling runoff and erosion and maintaining tilth and fertility.

6. Martin-Ladysmith Association

Deep, moderately well drained, nearly level to strongly sloping soils that have a silty clay subsoil; on uplands

This association consists of clayey soils on uplands, mostly in the southwestern quarter of the county (fig. 3). Limestone and shale crop out in a few places, and near these outcrops the soils may be steep and the slopes short. This association occupies about 22 percent of the county.

The Martin soils make up about 57 percent of this association; the Ladysmith soils, 17 percent; and minor soils, the remaining 26 percent.

The Martin soils developed in material weathered from shale. They are sloping and strongly sloping, moderately well drained, and medium acid to slightly acid. Their surface layer is dark-gray silty clay loam about 12 inches thick. The subsoil of dark grayish-brown silty clay is underlain by silty clay mottled with strong brown and yellowish brown.

The Ladysmith soils occur on ridgetops and are nearly level to gently sloping. These soils are moderately well drained and medium acid to slightly acid. They have a very dark gray silty clay loam surface layer about 10 inches thick, and a dense silty clay subsoil. The underlying material is gray silty clay mottled with strong brown.

Minor soils in this association are the Labette, Sogn, Vinland, Elmont, and Sibleyville. These soils are generally sloping, and all of them are in areas of limestone and shale.

About 55 percent of the acreage in this association is cultivated. The rest is mostly in range and pasture on which some hardwood trees grow along the streambanks. The arable soils are suited to the crops commonly grown in the county. Measures are needed on cropland for con-

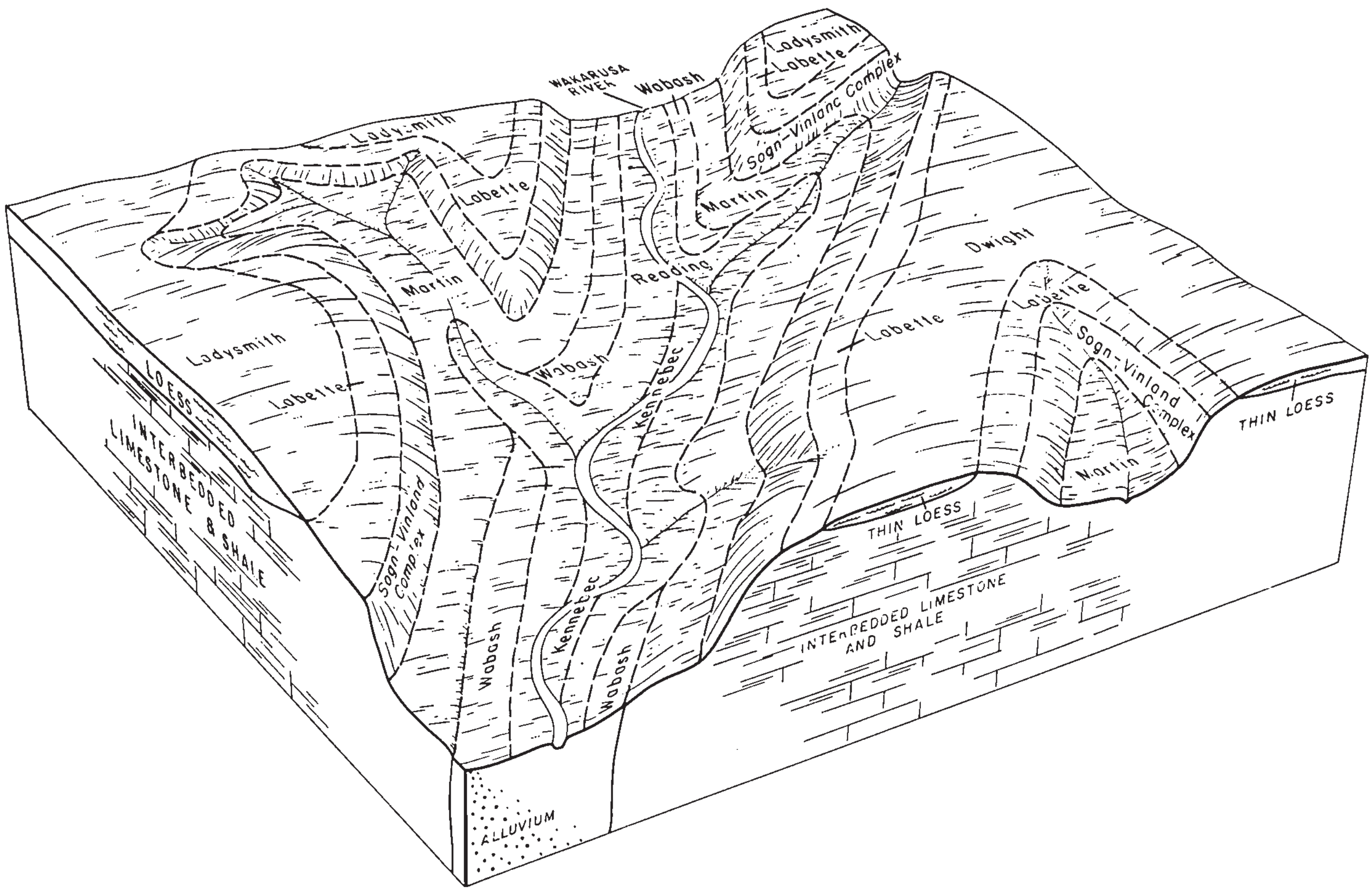

***Figure 3.*—Relation of soils to landscape in soil association 6 in the southwestern part of the county.**

trolling runoff and erosion and for maintaining soil tilth and fertility.

7. Gymer-Shelby-Sharpsburg Association

Deep, well-drained, sloping and strongly sloping soils that have a silty clay loam or clay loam subsoil; on uplands

This association consists of soils formed in loamy outwash and loessal materials. These soils are along the north and south bluffs of the valley of the Kansas River. Some small areas north of the Kansas River are overlain by eolian sands. The association covers about 5 percent of the county.

The Gymer soils occupy about 29 percent of this association; Shelby soils, 20 percent; Sharpsburg soils, 14 percent; and minor soils, the remaining 37 percent.

Gymer soils are sloping soils on ridgetops and side slopes. They are deep, well drained, and medium acid to slightly acid. They formed in reddish-brown, loamy, loessal material on uplands. Gymer soils have a surface layer of dark-brown silt loam about 8 inches thick. Their subsoil, about 34 inches thick, is dark-brown silty clay loam in the upper part. The underlying material is slightly acid silty clay loam.

Shelby soils generally are on side slopes and receive runoff from areas upslope. They are sloping and strongly sloping. They formed in glacial till and are well drained and medium acid. They have a very dark grayish-brown clay loam surface layer about 12 inches thick. Their subsoil, about 27 inches thick, is brownish clay loam, which overlies clay.

Sharpsburg soils commonly occur on ridgetops and are gently sloping and sloping. They are deep, well-drained soils that are medium acid to slightly acid. They formed in yellowish-brown, loamy, loessal material. In these soils silty clay loam extends from the surface to a depth of 72 inches.

Minor soils in this association are the Morrill, Shellabarger, Konawa, and Welda. These soils are on uplands and are friable, loamy, and sloping to strongly sloping.

In this association most areas of gently sloping and sloping soils are cultivated; the steeper soils and the more broken areas are commonly used for pasture. Trees grow around drainageways and in small areas of the steeper soils. The soils in this association are suited to all the crops grown in the county. The main concerns in managing the cultivated soils are controlling runoff and erosion and maintaining fertility. On rangeland, those practices that help maintain a vigorous stand of grass are needed.

8. Martin-Sogn Association

Deep, moderately well drained soils that have a silty clay subsoil and shallow, somewhat excessively drained soils; on uplands

This association consists of loamy soils on narrow ridgetops, on side slopes, and in small valleys. Rock escarpments are common on the steep side slopes. This association covers about 13 percent of the county.

The Martin soils make up 36 percent of the association. About 44 percent consists of the Sogn soils and soils (Vinland and Kipson) closely intermingled with them in complexes. Minor soils make up the remaining 20 percent.

The Martin soils are sloping and strongly sloping, deep, and moderately well drained. They are below or between limestone escarpments, and they generally receive runoff from soils upslope. Runoff is rapid to medium. In Martin soils the surface layer is dark-gray silty clay loam about 12 inches thick. The subsoil extends to a depth of 36 inches and is grayish-brown silty clay.

The Sogn soils formed over limestone and are very shallow and somewhat excessively drained. In this association Sogn soils are closely intermingled with Vinland soils and Kipson soils. They are in an intricate pattern consisting of rock escarpments and steep soils intermingled with more gently sloping soils. In Sogn soils very dark grayish-brown silty clay loam extends to a depth of 10 inches and is underlain by grayish-brown limestone.

Also in this association are small areas of Labette, Dwight, and Pawnee soils on the ridgetops, of Elmont, Shelby, and Morrill soils on the side slopes, and of Kennebec and Reading soils along the drainageways.

About 65 percent of the acreage in this association is grassland, and about 30 percent is cropland. The Sogn soils are not suited to cultivated crops, but they are well suited to tall prairie grasses. In this association hardwood trees grow along the streams and on the side slopes. They cover about 5 percent of the acreage. On cropland, practices are needed for controlling runoff and erosion and maintaining soil tilth and fertility. The main concern in managing grassland is maintaining a vigorous stand of grass.

Descriptions of the Soils

In this section the soil series and the mapping units in each series are described. The acreage and proportionate extent of each mapping unit are given in table 1.

The procedure is first to describe the soil series, and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. The description of a soil series mentions features that apply to all the soils in a series. Differences among the soils of one series are pointed out in the description of the individual soils or are indicated in the soil name. As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Alluvial land, for example, is a miscellaneous land type that does not belong to a soil series. It is listed, nevertheless, in alphabetic order along with the soil series.

A profile typical for each series is described in two ways. Many will prefer to read the short description in narrative form. It is the second paragraph in the series description. The technical profile is mainly for soil scientists and others who want detailed information about the soils. Some of the terms used to describe the soils are defined in the Glossary at the back of this soil survey. Others are defined in the "Soil Survey Manual" (*9*).[2]

Following the name of each mapping unit is a soil symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit, range site, and woodland suitability group in which the mapping unit has been placed. The pages on which each of these groups are described are given in the "Guide to Mapping Units" at the back of this survey.

Alluvial Land

Alluvial land (0 to 2 percent slopes) (An) occurs on flood plains in areas that are less than 300 feet wide and that are cut by a meandering stream channel. These areas are subject to frequent flooding because they lie along small intermittent streams that have shallow channels. This land occurs in all parts of the county. It has a loam to silty clay loam texture and is stratified.

About 15 percent of this land probably could be cultivated, but cultivation generally is not practical, because areas are small and inaccessible. Because frequent flooding is likely, most of the acreage is not suitable for cultivation. This land is used mostly for pasture, range, hay, or trees, but some areas are used for wildlife habitat or for recreation. (Capability unit VIw–1; Loamy Lowland range site; woodland suitability group 1)

Breaks-Alluvial Land Complex

Breaks-Alluvial land complex (Bk) consists of upland drainageways more than 100 feet wide that have narrow alluvial bottom lands and steep broken, nonarable side slopes or banks. The soil material is mostly from shale and limestone on the slopes of the drainageways and is alluvial on the bottom lands. Rocks and stones crop out in some small areas. Slopes range from about 3 percent on the bottom lands to 45 percent on the banks. This complex occurs in all parts of the county except where bottom lands are broad.

Breaks-Alluvial land is used only as range, woodland, wildlife habitat, and recreational areas. The steep slopes prevent cultivation and limit grazing by livestock. (Both parts of complex are in capability unit VIe–1; Breaks part is in Loamy Upland range site and woodland group 4; Alluvial land is in Loamy Lowland range site and woodland group 1)

Broken Alluvial Land

Broken alluvial land (Br) consists of channels cut by perennial streams and the steep to very steep banks

[2] Italic numbers in parentheses refer to Literature Cited, p. 75.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent
	Acres	*Percent*
Alluvial land	4, 636	1. 3
Breaks-Alluvial land complex	6, 568	1. 9
Broken alluvial land	7, 140	2. 0
Dwight-Martin silty clay loams, 1 to 3 percent slopes	2, 377	. 7
Dwight silty clay loam, 0 to 1 percent slopes	446	. 1
Dwight silty clay loam, 1 to 3 percent slopes	2, 083	. 6
Elmont silt loam, 3 to 7 percent slopes	2, 347	. 7
Elmont silt loam, 3 to 7 percent slopes, eroded	1, 187	. 3
Elmont silt loam, 7 to 12 percent slopes	1, 560	. 4
Elmont silt loam, 7 to 12 percent slopes, eroded	305	. 1
Elmont-Slickspots complex, 3 to 7 percent slopes, eroded	194	. 1
Eudora sandy loam, sandy variant, 1 to 3 percent slopes	246	. 1
Eudora silt loam	12, 231	3. 5
Eudora soils, 6 to 12 percent slopes, eroded	1, 498	. 4
Eudora-Kimo complex	6, 973	2. 0
Eudora-Kimo complex, overwash	538	. 2
Gymer silt loam, 3 to 8 percent slopes	3, 595	1. 0
Gymer silt loam, 3 to 8 percent slopes, eroded	484	. 1
Kennebec silt loam	4, 824	1. 4
Kennebec silt loam, clayey substratum	1, 405	. 4
Kimo silty clay loam	1, 747	. 5
Kimo soils, depressional	400	. 1
Kipson-Sogn complex	1, 425	. 4
Konawa fine sandy loam, 4 to 8 percent slopes	321	. 1
Konawa fine sandy loam, 8 to 12 percent slopes	276	. 1
Labette silty clay loam, 1 to 3 percent slopes	6, 446	1. 8
Labette silty clay loam, 3 to 6 percent slopes	7, 533	2. 1
Labette silty clay loam, 3 to 6 percent slopes, eroded	1, 692	. 5
Ladysmith silty clay loam, 0 to 1 percent slopes	4, 410	1. 3
Ladysmith silty clay loam, 1 to 3 percent slopes	28, 960	8. 3
Ladysmith silty clay loam, 1 to 3 percent slopes, eroded	569	. 2
Made land	150	(1)
Martin silty clay loam, 1 to 3 percent slopes	9, 536	2. 7
Martin silty clay loam, 3 to 7 percent slopes	50, 200	14. 4
Martin silty clay loam, 3 to 7 percent slopes, eroded	12, 663	3. 6
Martin silty clay loam, 7 to 11 percent slopes	7, 214	2. 1
Martin silty clay loam, 7 to 11 percent slopes, eroded	1, 217	. 3
Martin soils, 3 to 7 percent slopes, severely eroded	243	. 1
Morrill clay loam, 3 to 8 percent slopes	3, 128	. 9
Morrill clay loam, 3 to 8 percent slopes, eroded	1, 286	. 4
Morrill clay loam, 8 to 12 percent slopes	612	. 2
Morrill-Gravelly land complex, 4 to 12 percent slopes	630	. 2
Muir silt loam	9, 549	2. 7
Pawnee clay loam, 0 to 3 percent slopes	6, 084	1. 7
Pawnee clay loam, 3 to 7 percent slopes	34, 219	9. 8
Pawnee clay loam, 3 to 7 percent slopes, eroded	8, 067	2. 3
Pawnee clay loam, 7 to 11 percent slopes	489	. 1
Reading silty clay loam, 0 to 2 percent slopes	17, 900	5. 1
Riverwash	603	. 2
Sarpy sand	422	. 1
Sarpy-Eudora complex, overwash	2, 429	. 7
Sharpsburg silty clay loam, 1 to 3 percent slopes	821	. 2
Sharpsburg silty clay loam, 3 to 6 percent slopes	1, 337	. 4
Shelby clay loam, 1 to 3 percent slopes	707	. 2
Shelby clay loam, 3 to 8 percent slopes	3, 014	. 9
Shelby clay loam, 3 to 8 percent slopes, eroded	898	. 2
Shelby clay loam, 8 to 12 percent slopes	927	. 3
Shellabarger fine sandy loam, 3 to 8 percent slopes	834	. 2
Shellabarger fine sandy loam, 3 to 8 percent slopes, eroded	183	. 1
Shellabarger fine sandy loam, 8 to 12 percent slopes	190	. 1
Sibleyville loam, 3 to 7 percent slopes	675	. 2
Sibleyville loam, 7 to 11 percent slopes	426	. 1
Sogn-Vinland complex	30, 600	8. 8
Stony steep land	6, 126	1. 8
Vinland silty clay loam	1, 767	. 5
Wabash silty clay	6, 023	1. 7
Wabash silty clay loam	6, 673	1. 9
Welda silt loam, 4 to 10 percent slopes	193	. 1
Intermittent lakes	70	(1)
Water (lakes)	1, 132	. 3
Kansas River	3, 337	1. 0
Borrow areas	666	. 2
Limestone quarries and gravel pits	1, 144	. 3
Total	348, 800	100. 0

[1] Less than 0.05 percent.

along those streams. It occurs only in well-developed valleys and is near soils on bottom lands and terraces. The soil material is alluvial and ranges from loam to silty clay loam in texture. In some places sand, gravel, or cobblestones are in the stream channel.

Broken alluvial land is not suitable for cultivation, pasture, or range. Hardwood trees generally grow on the streambanks. Willow trees grow in spots along some stream channels. (Capability unit VIIw-1; not assigned to a range site; woodland suitability group 1)

Dwight Series

The Dwight series consists of deep, well drained to moderately well drained soils that have a claypan. These soils occur on ridgetops and are nearly level to gently sloping. In some places the Dwight soils developed directly over shale, but in others a thin mantle of loess has been deposited on the shale.

In a typical profile the surface layer is slightly acid, gray silty clay loam about 5 inches thick. The subsoil, about 31 inches thick, is dense clay in the upper part and silty clay in the lower part. It is extremely hard when dry. The upper part is mildly alkaline. In the lower part are many fine concretions of calcium carbonate, some gypsum crystals, and a few fine concretions of iron. The underlying material is moderately alkaline. It is dark grayish-brown silty clay loam to a depth of 50 inches and is strong-brown, dark-brown, and pale-brown silty clay loam below that depth. The underlying material contains varying amounts of gypsum crystals and calcium carbonate concretions.

Surface runoff is slow where these soils are nearly level and is medium where they are gently sloping. Per-

meability is very slow when these soils are moist but is rapid when they are dry and cracked. Because of the thin surface layer and the dense clay subsoil, these soils are droughty. Penetration of roots is restricted.

The native vegetation is mostly short and mid prairie grasses. Tall prairie grasses are sparse on these soils. Because available moisture capacity is low, the Dwight soils are poorly suited to cultivated crops. Nearly all of the acreage is range or hayland.

Typical profile of a Dwight silty clay loam (1,320 feet west, 100 feet north of the southeast corner of section 4, T. 13 S., R. 14 E.) in grassland:

A1—0 to 5 inches, gray (10YR 5/1) light silty clay loam, very dark gray (10YR 3/1) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; slightly acid; abrupt boundary.

B21t—5 to 22 inches, dark-gray (10YR 4/1) dense clay, very dark gray (10YR 3/1) when moist; moderate, medium, columnar structure that breaks easily to weak, coarse, angular blocky structure; extremely hard when dry, very firm when moist; distinct continuous clay films; mildly alkaline; gradual boundary.

B22t—22 to 28 inches, grayish-brown (10YR 5/2) dense clay, dark grayish brown (10YR 4/2) when moist; weak, coarse, angular blocky structure; extremely hard when dry, very firm when moist; clay films are less distinct than in the layer above; few fine concretions of calcium carbonate; mildly alkaline; gradual boundary.

B3—28 to 36 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) when moist; weak, coarse, subangular blocky structure; extremely hard when dry, very firm when moist; many fine concretions of calcium carbonate; some gypsum crystals and a few fine concretions of iron; moderately alkaline; gradual boundary.

C—36 to 50 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; common, medium, strong-brown mottles; massive; hard when dry, firm when moist; moderately alkaline; clear boundary.

IIC—50 to 80 inches, strong-brown (7.5YR 5/6), dark-brown (10YR 3/3), and pale-brown (10YR 6/3) silty clay; massive; very hard when dry, firm when moist; mildly alkaline.

The A horizon ranges from 3 to 8 inches in thickness. It is gray to dark grayish brown when dry. The A horizon is light silty clay loam or heavy silt loam. When the B horizon is dry, it ranges from dark brown and dark gray to light brownish gray. The solum ranges from 25 to 45 inches in thickness. The lower part of the B horizon and the C horizon contain varying amounts of concretionary calcium carbonate and iron and of gypsum crystals. The less clayey part of the C horizon ranges from 0 to 3 feet in thickness and probably is altered loess. Part of the solum may be formed in residual material.

The Dwight soils are distinguished from the Ladysmith soils by a surface horizon that is generally less than 8 inches thick and an abrupt boundary between the surface layer and the subsoil. Also, structure in the upper part of the subsoil of Dwight soils is not granular or subangular blocky as it is in the Ladysmith soils.

Dwight silty clay loam, 0 to 1 percent slopes (Ds).—This soil is on the crest of the drainage divides. It is wet for a short but significant period, but available moisture capacity is low. Included with this soil in mapping were small areas of Ladysmith soils.

Use of this Dwight soil is limited mainly by the thin surface layer and the claypan in the subsoil, which make the soil droughty and difficult to till. Rangeland should be managed so as to maintain maximum plant cover. (Capability unit IVs–1; Claypan range site; not assigned to a woodland suitability group)

Dwight silty clay loam, 1 to 3 percent slopes (Dw).—This soil occurs on drainage divides. It is well drained but has low available moisture capacity. Included with this soil in mapping were small areas of Ladysmith, Labette, and Martin soils.

If this soil is cultivated, management is needed for maintaining or improving soil tilth and fertility and for controlling erosion. Pasture and rangeland should be managed so as to maintain maximum plant cover. (Capability unit IVe–6; Claypan range site; not assigned to a woodland suitability group)

Dwight-Martin silty clay loams, 1 to 3 percent slopes (Dm).—These soils occur on ridgetops, mostly south of the Kansas River. They were mapped as a complex because they are so intermingled that it was not practical to map them separately. Dwight soil makes up about 50 to 75 percent of the complex, and Martin soil, about 25 to 50 percent. Included in mapping were small areas of Labette and Ladysmith soils. The profiles of the Dwight and Martin soils are described under their respective series.

The Dwight soil is well drained to moderately well drained, and the Martin soil is moderately well drained. Permeability is very slow in the Dwight soil and is slow in the Martin soil.

These soils are seldom cultivated. They are used mostly for range. The Martin soil supports tall prairie grasses, and the less fertile Dwight soil supports mid and short prairie grasses. (Both soils are in capability unit IVe–6; Dwight soil is in Claypan range site but is not assigned to a woodland group; Martin soil is in Loamy Upland range site and woodland group 4)

Elmont Series

The Elmont series consists of deep, well-drained soils. These soils are on uplands and are sloping to strongly sloping. They formed in material weathered from interbedded sandy and silty, noncalcareous shale.

In a typical profile the surface layer is very dark grayish-brown silt loam about 7 inches thick. The subsurface layer extends to a depth of 16 inches and is dark grayish-brown silty clay loam. The subsoil extends to a depth of 50 inches. It is silty clay loam to a depth of 42 inches and is silty clay below that depth. Colors are dark grayish brown, grayish brown, and light brownish gray, mottled throughout with reddish brown and strong brown. The underlying material is mottled reddish-brown and light brownish-gray silty clay.

Elmont soils are friable and easily worked where they are not severely eroded. They have high available moisture capacity, and they respond well to applications of fertilizer.

About half the acreage of Elmont soils is cultivated; the rest is mainly pasture or range. A few small areas are wooded.

Typical profile of Elmont silt loam, 3 to 7 percent slopes (200 feet north, 30 feet east of the southwest corner of the northwest quarter of section 36, T. 13 S., R. 14 E.) in grassland:

A11—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; slightly acid; gradual boundary.

A12—7 to 16 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, subangular blocky and moderate, medium, granular structure; slightly hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

B1—16 to 22 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; common, fine, reddish-brown mottles; moderate, fine, subangular blocky structure; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

B21t—22 to 35 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; common, fine, strong-brown and reddish-brown mottles; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; medium acid; gradual, smooth boundary.

B22t—35 to 42 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; distinct, common, fine, strong-brown and reddish-brown mottles; weak to moderate, medium, subangular blocky structure; very hard when dry, firm when moist; few, fine iron-manganese concretions; medium acid; gradual, smooth boundary.

B3—42 to 50 inches, light brownish-gray (10YR 6/2) light silty clay, grayish brown (10YR 5/2) when moist; common, coarse, distinct, strong-brown mottles; weak, medium, subangular blocky structure; very hard when dry, firm when moist; common, fine iron-manganese concretions; slightly acid; gradual, smooth boundary.

C—50 to 80 inches, coarsely mottled reddish-brown and light brownish-gray light silty clay; massive; very hard when dry, firm when moist; few fine iron-manganese concretions; some faint stratification in the lower 10 inches (shale).

In most places the A1 horizon is silt loam, but in some places it is light silty clay loam or clay loam. The dark color extends from the surface to a depth of 20 inches or more. The solum ranges from 30 to 50 inches in thickness.

The Elmont soils have a finer textured subsoil and a thicker solum than do Sibleyville soils and are less clayey throughout the profile than the Martin soils. Elmont soils lack the reddish-brown color of Gymer soils and are more distinctly mottled.

Elmont silt loam, 3 to 7 percent slopes (El) —This soil occurs on uplands. Its profile is the one described as typical for the Elmont series. Included with this soil in mapping were small areas of Martin silty clay loam and Sibleyville loam.

If properly managed, this Elmont soil is suited to all crops commonly grown in the county. In cultivated areas practices for controlling erosion and maintaining soil tilth and fertility are needed. (Capability unit IIIe–3; Loamy Upland range site; woodland suitability group 4)

Elmont silt loam, 3 to 7 percent slopes, eroded (Em).—This soil occurs on uplands. So much of the surface layer has been lost through erosion that normal tillage turns up subsoil material in about 15 to 25 percent of the acreage. In these areas the surface layer is lighter colored than the one in the profile described as typical for the Elmont series. In some areas gullies or gully scars are common.

This soil is suited to all crops commonly grown in the county. Because the hazard of erosion is severe in cultivated areas, intensive practices are needed to reduce loss of soil and to maintain or improve soil tilth and fertility. (Capability unit IIIe–5; Loamy Upland range site; woodland suitability group 4)

Elmont silt loam, 7 to 12 percent slopes (En).—This soil is on uplands. The surface layer and subsoil combined are 35 to 42 inches thick, but otherwise the profile of this soil is similar to the one described as typical for the Elmont series. Included with this soil in mapping were small areas of Martin and Sibleyville soils.

Because this soil is strongly sloping, erosion is the main hazard and is difficult to control. Pasture, range, and hayland are the main uses. (Capability unit IVe–3; Loamy Upland range site; woodland suitability group 4)

Elmont silt loam, 7 to 12 percent slopes, eroded (Eo).—This strongly sloping soil occurs on uplands. So much of the surface layer has been removed by erosion that normal tillage turns up subsoil material in about 15 to 25 percent of the acreage. In the eroded areas the surface layer is lighter colored than that in the profile described as typical for the Elmont series. In some places gullies or gully scars are common.

This soil was formerly cultivated, but now nearly all of the acreage is seeded to perennial grasses for pasture. This soil is not suited to cultivated crops, but it is well suited to pasture or range. (Capability unit VIe–1; Loamy Upland range site; woodland suitability group 4)

Elmont-Slickspots complex, 3 to 7 percent slopes, eroded (Ep).—This complex occurs on uplands, mostly north of the Kansas River. It consists of areas of Elmont soils interspersed with numerous slickspots and gullied areas. The gullied areas range from about 0.1 acre to about 1.0 acre in size. The slickspots make up about 20 to 25 percent of the acreage mapped. The soils in this complex formed in material weathered from sandy and silty shale.

In about 50 percent of the acreage, the original surface layer of the Elmont soil has been thinned or removed by erosion. The slickspots are barren. Gullies are common, and a few extend into the underlying shale.

Surface runoff is medium to rapid. Available moisture capacity is medium to low. Natural fertility is low.

All of this complex has been cultivated, but cultivation is no longer practical and has been abandoned. Perennial grasses are a better use than crops, but on grassland practices are needed to help control runoff and erosion and to improve soil tilth and fertility. Also needed is careful management of grazing so that a good stand of perennial grass can be maintained. Adequate fertilizer is needed for establishing and maintaining a vigorous stand of tame grass. (Both parts are in capability unit VIe–3; Elmont soils are in Loamy Upland range site and woodland group 4; Slickspots are in Claypan range site but are not assigned to a woodland group)

Eudora Series

The Eudora series consists of well-drained, neutral to moderately alkaline soils that formed in coarse silt loam or loam alluvium. These soils occur on the second, third, and fourth levels, or benches, in the valley of the Kansas River.

In a typical profile the surface layer is grayish-brown, moderately alkaline silt loam about 12 inches thick. It

is underlain by light brownish-gray coarse loam about 9 inches thick. Below this is light brownish-gray, stratified silt loam and very fine sandy loam about 7 inches thick. The next layer is light-gray coarse silt loam that is underlain by light-gray fine sand thinly stratified with numerous layers of silt loam and fine or very fine sandy loam.

Eudora soils are friable and easily worked. They are naturally fertile and have medium or high available moisture capacity. Crops on the Eudora soils respond well if fertilizer is added.

Nearly all the acreage is cultivated. Eudora soils are suited to all crops commonly grown in the county.

Typical profile of Eudora silt loam (1,050 feet north, 50 feet east of the southwest corner of section 20, T. 11 S., R. 15 E.) in a cultivated field:

A1—0 to 12 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; upper part is plow layer; some platy and weak granular structure in lower part; hard when dry, friable when moist; moderately alkaline; clear boundary.

C1—12 to 21 inches, light brownish-gray (10YR 6/2) coarse loam, grayish brown (10YR 5/2) when moist; massive; slightly hard when dry, very friable when moist; a few worm casts; moderately alkaline; clear boundary.

C2—21 to 28 inches, light brownish-gray (10YR 6/2) stratified silt loam and very fine sandy loam, grayish brown (10YR 5/2) when moist; silt loam is slightly darker than the very fine sandy loam; massive; slightly hard when dry, very friable when moist; numerous worm casts; mildly alkaline; clear boundary.

C3—28 to 42 inches, light-gray (10YR 7/1) coarse silt loam, gray (10YR 6/1) when moist; massive; slightly hard when dry, very friable when moist; moderately alkaline; calcareous; clear boundary.

C4—42 to 65 inches, light-gray (10YR 7/1) fine sand thinly stratified with numerous layers of silt loam and fine or very fine sandy loam; single grain; loose when dry and moist; moderately alkaline; calcareous.

The A horizon ranges from 10 to 24 inches in thickness. In most places it is grayish brown or dark grayish brown. Exceptions are where light brownish-gray, calcareous material has been recently deposited by floodwater. The C horizon is coarse silt loam or coarse loam. Depth to calcareous soil material in the C horizon ranges from 24 to 60 inches. Below a depth of 36 inches, these soils have loamy and sandy layers that vary in thickness and contain a thin clayey layer in places.

Eudora soils are coarser textured in the underlying layers than are the Muir soils. They are lighter colored and less clayey in the upper horizons than the associated Kimo soils and are less sandy than the Sarpy soils.

Eudora sandy loam, sandy variant, 1 to 3 percent slopes (Es).—This soil occurs as alluvial fans that formed where small drains carrying sandy material from the uplands empty onto the alluvial plain of the Kansas River. The texture of this soil is generally sandy loam, but in some places there are thin strata of silty soil material in the profile. Also, a fine textured or moderately fine textured buried soil is at a depth of 20 to 40 inches. Included with this sandy variant in mapping were small areas of a Kennebec silt loam.

On this sandy variant runoff is slow. Available moisture capacity and fertility are medium. This soil is very friable and is easily worked.

Crops grow well on this soil if it is protected from flooding and siltation and if fertilizer is added. Returning crop residue to the soil is a way to maintain good tilth. (Capability unit IIe–3; Sandy Lowland range site; woodland suitability group 5)

Eudora silt loam (0 to 2 percent slopes) (Et).—This soil occurs on bottom lands along the Kansas River. The profile of this soil is the one described as typical for the Eudora series. Included with this soil in mapping were small areas of Muir silt loam, Kimo silty clay loam, and Sarpy fine sandy loam.

Soil blowing is a slight hazard during winter and early spring months if adequate cover is not maintained. Where fertilizer is added, crops grow well under dryfarming. Growth of crops can be increased by irrigation if enough fertilizer is added and if irrigation water is used efficiently. This soil is suitable for leveling, where needed for irrigation. (Capability unit I–1; Loamy Lowland range site; woodland suitability group 6)

Eudora soils, 6 to 12 percent slopes, eroded (Eu).—These soils have a loam, silt loam, or silty clay loam surface layer in most places. In cultivated areas the dark-colored original surface layer has been removed by erosion.

These soils occur between levels, or benches, of the alluvial plains along all major streams in the county. Slopes are 100 to 300 feet long. Associated soils are the Muir and Reading.

These Eudora soils have medium to rapid surface runoff. Permeability is moderate. Organic-matter content is low in most cultivated areas.

Most of the acreage is cultivated, but a few of the steeper areas are wooded. Seeding to perennial grasses helps to control erosion, which is the main hazard. These soils respond well to additions of fertilizer. Returning all crop residue to the soil helps to maintain or increase the organic-matter content. (Capability unit IIIe–1; Loamy Lowland range site; woodland suitability group 6)

Eudora-Kimo complex (0 to 2 percent slopes) (Ev).—This complex consists of Eudora and Kimo soils on the second and third levels, or benches, in the valley of the Kansas River. These soils were mapped as a complex because they are so intermingled that it was not practical to map them separately. Each kind of soil makes up 30 to 70 percent of any area mapped. The profiles of the Eudora and Kimo soils are described under their respective series. Included with these soils in mapping were areas of Muir silt loam and Sarpy fine sandy loam that make up as much as 10 percent of some mapped areas.

All crops commonly grown in the county are suited to these soils. Crops grow well under dryfarming, and growth of crops can be increased through irrigation if fertilizer is added and irrigation water is used efficiently. These soils are suitable for land leveling to prepare them for irrigation. Soil blowing is a minor hazard on the Eudora soils, and drainage is an obstacle on the Kimo soils. (Both soils are in capability unit IIw–1; Eudora soils are in Loamy Lowland range site and woodland group 6; Kimo soils are in Clay Lowland range site and woodland group 2)

Eudora-Kimo complex, overwash (0 to 2 percent slopes) (Ew).—This complex occurs on the second and third levels, or benches, in the valley of the Kansas River. It consists of Eudora and Kimo soils on bottom lands. About 50 to 65 percent of this complex is Eudora soils, and 20 to 40 percent is Kimo soils. The soils in this

complex are so intermingled that it is not practical to map them separately. Included in mapping were small areas of Sarpy sand and of Sarpy-Eudora complex, overwash. The included areas do not exceed more than 15 percent of any area mapped. The profiles of the Eudora and Kimo soils are described under their respective series.

The soils in this complex were covered with a deposit of very pale brown sand and loamy fine sand during severe flooding in 1951. This deposit ranges from 6 to 30 inches in thickness and generally is thickest on the ridges. Microrelief is undulating. Immediately following the flood, much of the acreage was plowed to depths of 2 to 4 feet so that the finer textured underlying material would be brought up and mixed with the sandy material in the surface layer. In these deep-plowed areas and, in areas where the flood-deposited material was thin, the plow layer is now rather uniformly mixed and ranges from loamy fine sand to loam or light clay loam in texture.

Available moisture capacity is medium, and soil blowing is a minor hazard.

These soils are generally suited to all crops commonly grown in the county, including melons and vegetables, but growth of crops is somewhat less than on the Eudora and Kimo soils on which sediments were not deposited by floods. Gravity or sprinkler irrigation is suitable. Crop growth can be increased through the proper application of fertilizer and irrigation water. (Both soils are in capability unit IIw–1; Eudora soils are in Loamy Lowland range site and woodland group 6; Kimo soils are in Clay Lowland range site and woodland group 2)

Gymer Series

The Gymer series consists of deep, friable, well-drained soils. These soils are sloping and occur on uplands near the Kansas River. Gymer soils formed in reddish-brown Loveland loess.

In a typical profile the surface layer is dark-brown, medium acid silt loam about 8 inches thick. The subsoil extends to a depth of 42 inches and is medium acid, dark-brown and reddish-brown silty clay loam. Thin and patchy clay films and some concretions of iron and manganese occur in the lower part of the subsoil. The underlying material is slightly acid, brown silty clay loam.

Gymer soils have high available moisture capacity and moderately slow permeability. Crops on these soils respond well if fertilizer is added.

Most of the acreage of Gymer soils is cultivated or in pasture or range. These soils are suited to all crops commonly grown in the county.

Typical profile of Gymer silt loam, 3 to 8 percent slopes (200 feet west, 50 feet north of the southeast corner of the southwest quarter of section 34, T. 10 S., R. 14 E.) in native grass:

A1—0 to 8 inches, dark-brown (7.5YR 4/2) heavy silt loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; medium acid; gradual boundary.

B1—8 to 15 inches, dark-brown (7.5YR 4/2) light silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; medium acid; gradual boundary.

B21t—15 to 20 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) when moist; moderate, fine, subangular blocky structure; very hard when dry, friable when moist; thin, patchy clay films; medium acid; gradual boundary.

B22t—20 to 30 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium and fine, subangular blocky structure; very hard when dry, firm when moist; thin, patchy clay films; few, fine iron-manganese concretions; medium acid; gradual boundary.

B3—30 to 42 inches, silty clay loam that is reddish brown (5YR 4/4) when dry or moist; weak, medium and coarse, prismatic and moderate, medium, subangular blocky structure; very hard when dry, friable when moist; few, fine iron-manganese concretions; medium acid; gradual boundary.

C—42 to 80 inches, brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) when moist; massive; very hard when dry, friable when moist; slightly acid.

The A1 horizon is silt loam in most places, but it ranges to light silty clay loam. In the B2t horizon, clay films range from thin and patchy to distinct and continuous. Reaction ranges from medium acid to slightly acid throughout the soil profile. Colors in the B and C horizons range from brown to reddish brown.

Gymer soils are browner than the Elmont soils, which formed from weathered shale. Gymer soils are similar to Morrill soils in color, but the Morrill soils formed in loamy glacial material instead of loess. The surface layer of Gymer soils is darker colored than that of the Welda soils.

Gymer silt loam, 3 to 8 percent slopes (Gm).—This soil occurs on uplands. It has the profile described as typical for the Gymer series. Included with this soil in mapping were small areas of Morrill, Shelby, or Shellabarger soils.

If this Gymer soil is cultivated, water erosion is the most serious hazard. Runoff is medium. (Capability unit IIIe–1; Loamy Upland range site; woodland suitability group 3)

Gymer silt loam, 3 to 8 percent slopes, eroded (Gy).—This soil occurs on uplands. In cultivated areas much of the original dark-colored surface soil has been removed by erosion, and the present surface layer is brown to reddish brown. Gullies or gully scars are evident in some places.

Runoff is medium to rapid, and the main hazard is continued erosion. Growth of plants is 15 to 25 percent less than on the Gymer silt loams that are not more than slightly eroded. Available moisture capacity is high.

Most of this soil is in pasture, but cultivated crops probably can be grown if adequate measures are applied for controlling erosion. Cultivated crops and pasture plants respond well if fertilizer is added. (Capability unit IIIe–6; Loamy Upland range site; woodland suitability group 3)

Kennebec Series

The Kennebec series consists of deep, well-drained, loamy soils. These soils are nearly level, and they formed in alluvium on bottom lands of streams tributary to the Kansas River.

In a typical profile the surface layer (A11 horizon) is dark-gray silt loam about 16 inches thick. The subsurface layer extends to a depth of 48 inches and is dark grayish-brown silt loam. The underlying material is

grayish-brown silty clay loam. The profile is neutral throughout.

Kennebec soils are subject to occasional flooding. They have moderate permeability and high available moisture capacity.

The native vegetation on these soils is tall prairie grasses and deciduous lowland trees. Most of the acreage is cultivated, but a few areas are in pasture or range, and some areas remain wooded. Kennebec soils are suited to all crops commonly grown in the county.

Typical profile of Kennebec silt loam (400 feet north and 500 feet east of the southwest corner of the southeast quarter of section 14, T. 10 S., R. 16 E.) in a cultivated field:

A11—0 to 16 inches, dark-gray (10YR 4/1) heavy silt loam, very dark brown (10YR 2/2) when moist; moderate to weak, fine, granular structure; hard when dry, friable when moist; neutral; diffuse boundary.

A12—16 to 24 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) when moist; moderate to weak, fine, subangular blocky structure; hard when dry, friable when moist; neutral; gradual boundary.

A13—24 to 48 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine and medium, subangular blocky structure; hard when dry, friable when moist; neutral; diffuse boundary.

C—48 to 80 inches, grayish-brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, fine and medium, subangular blocky structure; hard when dry, friable when moist; neutral.

The A11 horizon is generally silt loam but is light silty clay loam in some places. The A12 and A13 horizons range from medium silt loam to light silty clay loam. These soils are commonly slightly acid to neutral, but they are medium acid in a few areas. In some places yellowish-brown and reddish-brown mottles occur below a depth of 30 inches.

Kennebec soils are generally coarser textured and have weaker structure than Reading soils. They are darker colored to a greater depth than Muir soils.

Kennebec silt loam (0 to 2 percent slopes) (Kb).—This soil occurs on the first bottoms of all the streams in the county except the Kansas River. The profile of this soil is the one described as typical for the Kennebec series. Included with this soil in mapping were areas of Reading silty clay loam, Wabash silty clay loam, and Wabash silty clay.

Flooding is a minor hazard on this Kennebec soil, but crops grow well in most years. Crops respond favorably if fertilizer is added. (Capability unit IIw–2; Loamy Lowland range site; woodland suitability group 1)

Kennebec silt loam, clayey substratum (0 to 2 percent slopes) (Kc).—This soil occurs where small drains empty material on the alluvial plain at the edge of the valley of the Kansas River. Unlike the profile described as typical for the Kennebec series, the profile of this soil has a finer textured buried soil at a depth of 20 to 40 inches. Included with this soil in mapping were small areas of Wabash and Reading soils.

Flooding and siltation are the major hazards, but crops are well suited if this Kennebec soil is adequately protected from flooding. Crops grown on this soil respond well to the application of fertilizer. (Capability unit IIw–2; Loamy Lowland range site; woodland suitability group 1)

Kimo Series

The Kimo series consists of deep, nearly level, somewhat poorly drained to poorly drained soils. These soils are on low terraces along the Kansas River. Typically, they occupy the lower lying meanders of old streams. Kimo soils formed in old alluvium consisting of clayey sediments underlain by distinctly contrasting lighter colored silty layers.

In a typical profile in a cultivated field, the surface layer is mildly alkaline, dark-gray silty clay loam about 7 inches thick. The subsurface layer, about 8 inches thick, is neutral, grayish-brown silty clay. The next layer, about 9 inches thick, is neutral, grayish-brown silty clay loam in the upper part. The lower part is silty clay loam with mixed colors that are about 60 percent light brownish gray and 40 percent very dark grayish brown. The underlying material is mildly alkaline, light-gray very fine sandy loam underlain by light brownish-gray silt loam stratified with light-gray very fine sandy loam.

Surface runoff and permeability are slow. Kimo soils have high to medium available moisture capacity.

Nearly all the acreage of these soils is cultivated, but a few small areas remain in trees. If Kimo soils are adequately drained and fertilized, they are suited to all crops commonly grown in the county.

Typical profile of Kimo silty clay loam (125 feet south, 125 feet east of the northwest corner of the northeast quarter of section 36, T. 10 S., R. 12 E.):

Ap—0 to 7 inches, dark-gray (10YR 4/1) heavy silty clay loam, very dark gray (10YR 3/1) when moist; very hard when dry, firm when moist; mildly alkaline; gradual, smooth boundary.

A1—7 to 15 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; extremely hard when dry, very firm when moist; neutral; noncalcareous; clear boundary.

AC1—15 to 20 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; some darker streaks or stains; weak, medium, subangular blocky structure; very hard when dry, firm when moist; neutral; noncalcareous; clear boundary.

AC2—20 to 24 inches, light silty clay loam that has mixed colors; 60 percent light brownish gray (10YR 6/2) and 40 percent very dark grayish brown (10YR 3/2) when horizon is dry, and dark grayish brown (10YR 4/2) and very dark brown (10YR 2/2) when horizon is moist; common, fine, strong-brown mottles; weak, fine, subangular blocky structure; hard when dry, friable when moist; mildly alkaline; noncalcareous; diffuse boundary.

C1—24 to 42 inches, light-gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) when moist; common, fine, strong-brown mottles; massive; soft when dry, very friable when moist; mildly alkaline; noncalcareous; diffuse boundary.

C2—42 to 60 inches, light brownish-gray (10YR 6/2) coarse silt loam, dark grayish brown (10YR 4/2) when moist, stratified light-gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) when moist; massive; soft when dry, very friable when moist; mildly alkaline; noncalcareous.

The Ap and A1 horizons range from medium silty clay loam to light silty clay. Depth to the light-colored silty and loamy material ranges from 16 to 36 inches. In most places the C horizon is coarse silt loam, but its texture ranges from fine sandy loam to medium silt loam. Reaction throughout the profile is neutral to mildly alkaline.

Kimo soils have a layer of light loamy material within 40 inches of the surface, whereas Wabash soils are silty clay to a depth of more than 40 inches. Kimo soils have finer textured surface and subsurface layers than Eudora soils.

Kimo silty clay loam (0 to 1 percent slopes) (Km).—This soil has the profile described as typical for the Kimo series. Included with this soil in mapping were small areas of Wabash, Muir, and Eudora soils.

Wetness is the main obstacle in managing this Kimo soil, but practices are also needed for maintaining tilth and fertility. (Capability unit IIw–1; Clay Lowland range site; woodland suitability group 2)

Kimo soils, depressional (0 to 1 percent slopes) (Ko).—These soils occur in abandoned stream channels on the alluvial plain of the Kansas River. They are poorly drained because the depressions restrict surface runoff and a clayey layer restricts internal drainage. Included with these soils in mapping were small areas of Wabash soils.

In many places the surface layer is very dark, massive heavy silty clay loam or silty clay that ranges from 24 to 40 inches in thickness. The underlying material generally consists of lighter colored, mottled strata that range from fine sand to silty clay in texture. In some places a silt loam surface layer, 6 to 15 inches thick, is underlain by a massive, fine-textured layer.

During most years shallow water covers the surface long enough to make cultivation impractical, but some areas are cultivated during extended dry periods. The native vegetation is willow and cottonwood trees, prairie cordgrass, and sedges. In cultivated fields smartweeds are common invaders. (Capability unit Vw–1; Clay Lowland range site; woodland suitability group 2)

Kipson Series

The Kipson series consists of somewhat excessively drained, shallow soils that formed in highly calcareous, weakly consolidated silty shale. These soils are gently sloping to strongly sloping and occur on uplands in the northwestern part of the county.

In a typical profile the surface layer is dark-gray, mildy alkaline silty clay loam about 8 inches thick. The underlying material extends to a depth of 17 inches and is light brownish-gray silty clay loam. It is underlain by mildly alkaline, light-gray platy shale.

Surface runoff is medium to rapid. Permeability is moderately slow. Kipson soils are somewhat droughty, for available moisture capacity is medium to low. Internal drainage is restricted by the underlying shale.

Most of the acreage of these soils is in native prairie grasses and is used for pasture and hay. A few small areas are in cultivated fields but are not suitable for cultivation.

Typical profile of Kipson silty clay loam (400 feet north, 50 feet west of the southeast corner of the northeast quarter of section 1, T. 10 S., R. 12 E.) in grassland:

A1—0 to 8 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; moderate, medium, granular structure; hard when dry, firm when moist; calcareous; mildly alkaline; gradual boundary.

C—8 to 17 inches, light brownish-gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) when moist; weak, fine, subangular blocky structure; hard when dry, firm when moist; few small fragments of shale; calcareous but without segregated calcium carbonate; mildly alkaline; clear boundary.

R—17 to 36 inches, light-gray (10YR 7/2) platy shale, light brownish gray (10YR 6/2) when moist; calcareous; mildly alkaline.

The A horizon is dark gray to grayish brown when dry. The color of the C horizon ranges from gray to pale brown. Depth to somewhat weathered shale ranges from 8 to 20 inches. Above the R horizon, texture is heavy silt loam and silty clay loam. The content of shale and limestone fragments ranges from less than 1 percent to about 20 percent of the soil mass.

Kipson soils are not so deep as the nearby Martin, Elmont, and Labette soils. Kipson soils are calcareous, whereas Vinland soils are noncalcareous.

Kipson-Sogn complex (3 to 25 percent slopes) (Ks).—This complex consists of soils that are shallow and very shallow to interbedded limestone and calcareous shale. The shallow Kipson soils occur in narrow bands between areas of the very shallow Sogn soils that have outcrops of limestone. These soils are on uplands in the northwestern corner of the county. The Kipson and Sogn soils are so intermingled that it was not practical to map them separately. About 35 to 65 percent of the complex is Kipson soils, 25 to 50 percent is Sogn soils, and 10 to 15 percent is Martin silty clay loam, Elmont silt loam, or Labette silty clay loam.

The soils in this complex are somewhat excessively drained; runoff is medium to rapid. Permeability is moderate to moderately slow. Because these soils are shallow or very shallow to limestone and shale, internal drainage is restricted.

The native vegetation is mixed prairie grasses. All the acreage is in range or hayland. Forage grasses grow well if the range is well managed. (Both kinds of soil in capability unit VIe–2; Kipson soils in Limy Upland range site, and Sogn soils in Shallow range site; neither kind of soil assigned a woodland suitability group)

Konawa Series

The Konawa series consists of well-drained, sloping and strongly sloping soils. These soils occur on uplands bordering the alluvial plain of the Kansas River. They formed in loamy sediments of Pleistocene age.

In a typical profile the surface layer is slightly acid, gray fine sandy loam about 8 inches thick. The subsurface layer is light brownish-gray fine sandy loam about 12 inches thick. The subsoil extends to a depth of 50 inches. The upper part is brown fine sandy loam, the middle part is brown sandy clay loam, and the lower part is brown clay loam. The underlying material is also brown clay loam.

Konawa soils have medium available moisture capacity and moderate permeability. Crops on these soils respond well if lime and fertilizer are added.

Most of the acreage of these soils is in grass. Some scattered acres are in deciduous trees, some are cultivated, and a few small areas remain wooded. Konawa soils are well suited to grass or trees. A limited acreage could be cultivated if erosion were controlled and proper amounts of fertilizer were added. Konawa soils are suited to all crops commonly grown in the county.

Typical profile of Konawa fine sandy loam, 4 to 8 percent slopes (800 feet south, 100 feet west of the north-

east corner of the southeast quarter of section 11, T. 11 S., R. 15 E.) in woodland:

A1—0 to 8 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) when moist; weak, very fine, granular structure; slightly hard when dry, very friable when moist; slightly acid; clear boundary.

A2—8 to 20 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; cloddy material that breaks readily to weak, very fine, granular structure; slightly hard when dry, very friable when moist; strongly acid; gradual boundary; lower 4 inches contains a few chunks from the B1 horizon.

B1—20 to 24 inches, brown (10YR 5/3) heavy fine sandy loam that has light brownish-gray (10YR 6/2) coatings on most ped faces, dark brown (10YR 4/3) when moist; weak, medium and fine, subangular blocky structure; very hard when dry, friable when moist; medium acid; gradual boundary.

B2t—24 to 34 inches, brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) when moist; weak, medium, subangular blocky structure; very hard when dry, firm when moist; clay films are thin and nearly continuous; medium acid; gradual boundary.

B3—34 to 50 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) when moist; weak, medium and coarse, subangular blocky structure; hard when dry, friable when moist; clay films thin and patchy; medium acid; diffuse boundary.

C—50 to 63 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist; medium acid.

The A1 horizon ranges from 6 to 14 inches in thickness and from medium acid to slightly acid. The A2 horizon ranges from 5 to 12 inches in thickness and from gray to very pale brown in color. The color of the B horizon ranges from brown to reddish brown and yellowish red.

Konawa soils have lighter colored surface and subsurface layers and a browner subsoil than the Shellabarger soils. Konawa soils are coarser textured than Morrill, Shelby, and Welda soils.

Konawa fine sandy loam, 4 to 8 percent slopes (Ku).—This soil occurs on uplands. It has the profile described as typical for the Konawa series. Included with this soil in mapping were small areas of Gymer silt loam, Morrill clay loam, and Shellabarger fine sandy loam. These included areas have slopes of 3 to 8 percent.

This Konawa soil can be cultivated if it is managed so that erosion is controlled. (Capability unit IIIe-4; Savannah range site; woodland suitability group 8)

Konawa fine sandy loam, 8 to 12 percent slopes (Kw).—This soil occurs on uplands. Included with it in mapping were areas of Morrill, Shelby, and Shellabarger soils. The included areas have slopes of 8 to 12 percent.

Use of this Konawa soil is limited mainly by erosion. If it is cultivated, intensive practices are needed to reduce loss of soil. (Capability unit IVe-4; Savannah range site; woodland suitability group 8)

Labette Series

The Labette series consists of deep and moderately deep, well-drained soils that developed in residuum from limestone or from interbedded limestone and calcareous shale. These soils commonly occur on ridgetops and are gently sloping to sloping. Limestone and limy shale crop out in some areas.

In a typical profile the surface layer is slightly acid, very dark grayish-brown silty clay loam about 9 inches thick. The subsurface layer, about 4 inches thick, is also slightly acid, very dark grayish-brown silty clay loam, but the silty clay loam is slightly finer textured than the layer above. The subsoil extends to a depth of 42 inches. The upper part is dark-brown silty clay mottled with strong brown. The lower part is brown silty clay also mottled with strong brown. A few shotlike iron concretions occur in the lower part of the subsoil. The underlying material consists of yellowish-brown silty clay about 4 inches thick. It rests on limestone.

Labette soils have high to medium available moisture capacity. Surface runoff is medium, and permeability is moderately slow. In some areas the underlying rock is at a depth of less than about 36 inches, and in these areas crops may be damaged by short periods of dry weather.

About 60 percent of the acreage of Labette soils is cultivated, and the rest is in pasture, range, or hay. These soils are generally suited to all crops commonly grown in the county.

Typical profile of Labette silty clay loam, 1 to 3 percent slopes (1,200 feet south, 30 feet east of the northwest corner of the southwest quarter of section 27, T. 12 S., R. 16 E.) in native grassland:

A1—0 to 9 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; slightly acid; clear boundary.

A3—9 to 13 inches, very dark grayish-brown (10YR 3/2) heavy silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; slightly acid; clear boundary.

B21t—13 to 22 inches, dark-brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; few, fine, faint, strong-brown mottles; thin, continuous clay films; slightly acid; gradual boundary.

B22t—22 to 42 inches, brown (7.5YR 5/2) silty clay, dark brown (7.5YR 4/2) when moist; weak, medium, subangular blocky structure; common, medium, strong-brown mottles; very hard when dry, very firm when moist; clay films thin and continuous in the upper part and thin and patchy in the lower part; few ferromanganese concretions; slightly acid; gradual boundary.

C—42 to 46 inches, yellowish-brown (10YR 5/6) silty clay, dark yellowish brown (10YR 4/6) when moist; massive; very hard when dry, firm when moist; neutral.

R—46 inches, limestone.

The A1 horizon ranges from very dark grayish brown to very dark brown or brown. The B horizon ranges from dark brown to reddish brown in color and from heavy silty clay loam to silty clay in texture. Depth to bedrock ranges from 30 to 70 inches.

Labette soils have browner colors than the Martin and Ladysmith soils. They have colors and textures similar to those of the Reading soils, which developed in deep alluvial material.

Labette silty clay loam, 1 to 3 percent slopes (La).—This soil occupies ridgetops. It has the profile described as typical for the Labette series. Included with this soil in mapping were small areas of Ladysmith, Dwight, Martin, and Sogn soils.

In using this Labette soil, erosion is a slight hazard. In short periods of dry weather, corn is likely to be dam-

aged in a few areas where the soil is shallow to limestone. Management is needed that helps to control erosion and that provides adequate fertilizer. (Capability unit IIe-1; Loamy Upland range site; woodland suitability group 4)

Labette silty clay loam, 3 to 6 percent slopes (Lb).—This soil is on narrow ridgetops and side slopes. It has a profile similar to the one described as typical for the Labette series. Included with this soil in mapping were small areas of Martin, Sogn, and Vinland soils and of Labette soils that are eroded.

The main management requirements on this Labette soil are controlling runoff and erosion. Crops respond well if fertilizer is added. (Capability unit IIIe-3; Loamy Upland range site; woodland suitability group 4)

Labette silty clay loam, 3 to 6 percent slopes, eroded (Lc).—This soil occurs mostly near the head of small drainageways. It is in positions similar to those of Labette silty clay loam, 3 to 6 percent slopes. Included with this eroded soil in mapping were small areas of Martin soils and of Labette silty clay loam, 3 to 6 percent slopes.

This soil is or has been cultivated. The main management requirements are controlling runoff and further erosion. Also needed in cultivated areas are additions of fertilizer. Planting row crops, especially corn, should be limited or avoided. Perennial grasses and legumes are well suited to this soil. (Capability unit IIIe-5; Loamy Upland range site; woodland suitability group 4)

Ladysmith Series

The Ladysmith series consists of deep, moderately well drained, silty soils that have a clayey subsoil. These soils are nearly level to gently sloping and occur on uplands throughout the county. They formed in fine-textured sediments, probably loess or old alluvial deposits.

In a typical profile the surface layer is very dark gray silty clay loam about 10 inches thick. The subsoil, which is silty clay throughout, extends to a depth of 48 inches. Colors are dark gray and gray that is mottled with yellowish brown and strong brown. The underlying material is gray silty clay mottled with strong brown.

Ladysmith soils have slow to very slow permeability. Surface runoff is slow where these soils are nearly level and is medium where they are sloping. These soils have moderately high available moisture capacity. Crops on the Ladysmith soils respond well to additions of fertilizer.

Most of the acreage of these soils is cultivated, but a few areas are in pasture or range. Ladysmith soils are suited to all crops commonly grown in the county, but corn does not do so well as grain sorghum or soybeans.

Typical profile of Ladysmith silty clay loam, 0 to 1 percent slopes (100 feet south and 50 feet east of the northwest corner of the southwest quarter of section 7, T. 13 S., R. 16 E.) in grassland:

A1—0 to 10 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, fine, granular structure; hard when dry, friable when moist; neutral; clear, smooth boundary.

B1—10 to 12 inches, dark-gray (10YR 4/1) light silty clay, black (10YR 2/1) when moist; moderate, fine and very fine, subangular blocky structure; very hard when dry, firm when moist; medium acid; clear, smooth boundary.

B21t—12 to 24 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; moderate, medium, subangular blocky structure; extremely hard when dry, very firm when moist; distinct, continuous clay films; medium acid to slightly acid; gradual, smooth boundary.

B22t—24 to 32 inches, gray (2.5Y 6/1) silty clay, gray (10YR 5/1) when moist; moderate, medium, subangular blocky structure; extremely hard when dry, very firm when moist; few, fine, yellowish-brown mottles; thin, patchy clay films; neutral; gradual, smooth boundary.

B3—32 to 48 inches, gray (2.5Y 6/1) light silty clay, gray (2.5Y 5/1) when moist; weak, medium, subangular blocky structure; very hard when dry, firm when moist; common, medium, strong-brown mottles; few concretions of calcium carbonate in the 32- to 38-inch zone; mildly alkaline; gradual, smooth boundary.

C—48 to 72 inches, gray (10YR 5/1) light silty clay, dark gray (10YR 4/1) when moist; massive; very hard when dry, firm when moist; coarsely mottled with strong brown; few, soft, black concretions; mildly alkaline.

The A1 horizon ranges from 7 to 14 inches in thickness. When it is dry, it ranges from very dark gray to grayish brown. The mottles in the B horizon are generally faint above a depth of 30 inches and are distinct below a depth of about 36 inches. The concretions of calcium carbonate in the B3 horizon range from few to many and are less than 5 millimeters in diameter.

Ladysmith soils have a thinner B1 horizon than the Pawnee soils and lack the A3 horizon of the Labette soils and the AB horizon of the Martin soils. Also, Ladysmith soils have a thicker surface layer than do the Dwight soils.

Ladysmith silty clay loam, 0 to 1 percent slopes (Ld).—This soil occurs on ridgetops throughout the county. An extensive area occurs in the vicinity of Forbes Air Force Base. The profile of this soil is the one described as typical for the Ladysmith series. Included with this soil in mapping were small areas of Martin and Labette soils.

Because of the tight clay subsoil and moderately slow surface runoff, crops grown on this Ladysmith soil are sometimes damaged by too much moisture during periods of excessive rainfall. Erosion is likely in cultivated areas. Grain sorghum and soybeans grow better than corn on this soil. (Capability unit IIs-1; Clay Upland range site; not assigned to a woodland suitability group)

Ladysmith silty clay loam, 1 to 3 percent slopes (Lm).—This soil occurs on the side slopes of ridgetops throughout the county. In cultivated areas the surface layer of this soil normally is slightly thinner than the one in the profile described as typical for the Ladysmith series. Included with this soil in mapping were small areas of Martin silty clay loam, Labette silty clay loam, and Pawnee clay loam, all of which have slopes of 1 to 3 percent.

Grain sorghum and soybeans grow better than corn on this Ladysmith soil. The main concerns in managing this soil are maintaining soil tilth and controlling runoff and erosion. (Capability unit IIIe-2; Clay Upland range site; not assigned a woodland suitability group)

Ladysmith silty clay loam, 1 to 3 percent slopes, eroded (Ls).—This soil occurs on the side slopes that extend from ridges. It generally is near the head of small drainageways. So much of the original surface layer has been washed away that ordinary tillage extends through the remaining part of the surface layer and into the subsoil.

The present plow layer is a mixture of the original surface soil and the subsoil. In these eroded areas the surface layer is lighter colored than that in uneroded areas.

This soil is fairly well suited to all crops commonly grown in the county, but it is better suited to small grains and grasses than to row crops. Crop growth can be increased by additions of fertilizer. In cultivated fields organic matter in the form of crop residue is needed for improving soil structure, maintaining or improving fertility, and controlling erosion. In addition to use of crop residue, practices, such as terracing, contour farming, and use of close-growing crops, are needed for controling erosion. (Capability unit IVe-1; Claypan range site; not assigned a woodland suitability group)

Made Land

Made land (Ma) consists of areas that have been filled with rocks, trash, or other debris and then covered with soil material and smoothed. Deep cuts and fills have been made in some sizable areas to prepare them for housing developments or industrial sites. In these areas the soil materials generally have a wide range in texture.

About a mile northeast of Tecumseh, an upland area 52 acres in size was leveled for an industrial plant. Made land occurs mainly in or near the city of Topeka. (Not assigned to a capability unit, range site, or woodland suitability group)

Martin Series

The Martin series consists of moderately well drained, medium acid to slightly acid soils that are gently sloping to strongly sloping. These soils occur throughout the county on uplands. In most places these soils are below limestone outcrops, but in some areas they occur above the outcrops. Martin soils developed in soil material weathered from interbedded silty and clayey shale and clay beds.

In a typical profile the surface layer is slightly acid, dark-gray silty clay loam about 12 inches thick (fig. 4). The subsurface layer, about 5 inches thick, is medium acid, very dark grayish-brown silty clay loam. The subsoil extends to a depth of 36 inches and consists of grayish-brown silty clay mottled with reddish brown. In the upper and middle parts are distinct, continuous clay films and a few fine iron-manganese concretions. The underlying material is light olive-brown silty clay that is mottled with strong brown and yellowish brown. It contains small fragments of shale and lies on soft shale.

Martin soils are generally well supplied with organic matter and have high available moisture capacity and slow permeability. Crops on these soils respond well to the addition of fertilizer.

About 70 percent of the acreage of Martin soils is cultivated, and most of the rest is in pasture or range. A few small areas are wooded. These soils are well suited to all crops commonly grown in the county. Legumes grow especially well because moisture from higher, steeper slopes is usually near the surface.

Typical profile of a Martin silty clay loam (1,300 feet east, 150 feet north of the southwest corner of section 19, T. 13 S., R. 15 E.) in grassland:

A1—0 to 12 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium, granular structure; hard when dry, firm when moist; slightly acid; gradual, smooth boundary.

AB—12 to 17 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist; clay films on most peds; medium acid; gradual, smooth boundary.

B21t—17 to 22 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; common, fine, reddish-brown mottles; moderate, fine and medium, subangular blocky structure; very hard when dry, firm when moist; distinct, continuous clay films; few fine iron-manganese concretions; medium acid; gradual, smooth boundary.

B22t—22 to 30 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) when moist; common, fine, reddish-brown mottles; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; distinct, continuous clay films; few fine iron-manganese concretions; slightly acid; gradual, smooth boundary.

B3—30 to 36 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) when moist; few, fine, reddish-brown mottles; weak, medium, subangular blocky structure; very hard when dry, firm when moist; few clay films; neutral; gradual boundary.

C1—36 to 72 inches, light olive-brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) when moist; common, fine, strong-brown and yellowish-brown mottles; massive or weak, medium, subangular blocky structure; very hard when dry, firm when moist; many fine iron-manganese concretions and small fragments of shale; some clay films on vertical and horizontal crevice walls; neutral; gradual boundary.

C2—72 to 96 inches, pale-yellow (2.5Y 7/4), soft, calcareous shale, light yellowish brown (2.5Y 6/4) when moist; coarse concretions of calcium carbonate between depths of 72 and 88 inches.

The A1 horizon is very dark gray to dark grayish brown when dry. Depth to the B horizon ranges from 10 to 20 inches. Mottles generally are faint in the upper part of the B horizon but are distinct in the lower part of the B and in the C horizon. These soils are noncalcareous throughout, but in places they contain a few calcium carbonate concretions in the lower part of the B horizon and in the C horizon.

Martin soils are finer textured throughout the profile than Elmont soils. Martin soils are not so brown as the Labette soils. An AB horizon occurs between the surface layer and subsoil of Martin soils, but this layer is missing in the Ladysmith soils.

Martin silty clay loam, 1 to 3 percent slopes (Mb).—This soil generally occurs on ridgetops or adjacent side slopes above limestone outcrops. The profile of this soil is similar to the one described as typical for the Martin series. Included with this soil in mapping were small areas of Ladysmith silty clay loam, 1 to 3 percent slopes, and of Labette silty clay loam, 1 to 3 percent slopes.

On this Martin soil the main management requirements are controlling erosion and maintaining soil tilth and fertility. (Capability unit IIe-1; Loamy Upland range site; woodland suitability group 4)

Martin silty clay loam, 3 to 7 percent slopes (Mc).—This soil commonly occurs immediately below limestone outcrops. It has a profile similar to the one described as typical for the Martin series. Included with this soil in mapping were small areas of Elmont silt loam, 3 to 7 percent slopes. Also included were some Martin and Elmont soils that have slopes of 7 to 11 percent.

The main management needs on this Martin soil are practices for controlling surface runoff. All crops respond well if tilth is maintained and adequate fertilizer is added. (Capability unit IIIe-3; Loamy Upland range site; woodland suitability group 4)

Martin silty clay loam, 3 to 7 percent slopes, eroded (Me).—This soil commonly occurs below limestone outcrops. So much of the original surface soil has been removed by erosion that ordinary tillage has mixed subsoil material with the remaining surface soil. In some areas a few shallow gullies or gully scars are evident. Included with this soil in mapping were small areas of Elmont silt loam, 3 to 7 percent slopes, and of Elmont silt loam, 3 to 7 percent slopes, eroded.

Because this Martin soil is susceptible to further damage by erosion, practices are needed to reduce the loss of soil. Also needed are practices that maintain or improve tilth and fertility and increase organic-matter content. (Capability unit IIIe-5; Clay Upland range site; woodland suitability group 4)

Martin silty clay loam, 7 to 11 percent slopes (Mf).—This soil occurs below limestone outcrops. The surface layer and subsoil combined are somewhat less thick than those in the profile described as typical for the Martin series. Runoff is medium to rapid. Included with this soil in mapping were small areas of Elmont silt loam, 3 to 7 percent slopes, and of Martin silty clay loam, 3 to 7 percent slopes. Also included were a few areas of Elmont and Martin soils that are eroded.

Most of the acreage of this uneroded Martin soil is used for range and pasture, but a few areas are cultivated or wooded. The hazard of erosion limits use of this soil for row crops, but small grains, legumes, and grasses are well suited. The main concerns of management are controlling runoff and maintaining soil tilth and fertility. (Capability unit IVe-3; Loamy Upland range site; woodland suitability group 4)

Martin silty clay loam, 7 to 11 percent slopes, eroded (Mh).—This soil occurs below limestone outcrops. It is or has been damaged by erosion to the extent that the present plow layer is a mixture of the original surface soil and a moderate amount of subsoil. Shallow gullies or gully scars occur in most places. Included with this soil in mapping were small areas of slightly eroded Martin silty clay loam, of moderately eroded Elmont silt loam, and of Vinland silty clay loam.

The main management needs are practices that control surface runoff and erosion and that establish and maintain adequate stands of perennial grasses. (Capability unit VIe-1; Clay Upland range site; woodland suitability group 4)

Martin soils, 3 to 7 percent slopes, severely eroded (Mk).—These soils commonly occur below or between outcrops of limestone. They are in upland areas that have been severely damaged by erosion. In 75 percent or more of the mapped areas, the original surface soil has been washed away. In many places gullies or gully scars extend into the underlying material or the underlying shale (fig. 5). Included with these soils in mapping were small areas of Vinland soils and of Martin soils on slopes of more than 7 percent

Martin soils, 3 to 7 percent slopes, severely eroded, are not suitable for cultivation. The main management practices needed are those that control surface runoff and erosion. Also needed are practices for improving soil fertility and establishing an adequate stand of perennial grasses. (Capability unit VIe-3; Clay Upland range site; woodland suitability group 4)

Figure 4.—Profile of a Martin silty clay loam showing the thick, dark-colored surface layer.

Morrill Series

The Morrill series consists of deep, well-drained soils that are gently sloping to strongly sloping. These soils are on uplands and occur in all of the county except the southwestern part. They formed in highly leached glacial till.

In a typical profile the surface layer is medium acid, very dark grayish-brown light clay loam about 9 inches thick. The subsurface layer is about 8 inches thick and consists of medium acid, dark-brown clay loam. The subsoil extends to a depth of 48 inches and is clay loam throughout. In the upper part the subsoil is medium acid. The lower part is slightly acid and contains a few fine concretions that are round and black. The underlying material is yellowish-brown clay loam.

These soils take in large amounts of water that can be used by plants. Crops on these soils respond well to additions of lime and commercial fertilizer.

Figure 5.—**Deep gullies are common on severely eroded Martin soils.**

About one-half of the acreage is cultivated. The rest is in pasture, range, or hay. Morrill soils are suited to all crops commonly grown in the county.

Typical profile of Morrill clay loam, 3 to 8 percent slopes (1,200 feet south, 300 feet east of the northwest corner of section 20, T. 10 S., R. 15 E.):

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) light clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; medium acid; clear, smooth boundary.

AB—9 to 17 inches, dark-brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

B2t—17 to 32 inches, clay loam that is reddish brown (5YR 4/3) when dry and moist and has dark reddish-brown (5YR 3/3) coatings; moderate, medium and fine, subangular blocky structure; distinct continuous clay films; very hard when dry, firm when moist; few, fine, round, black concretions; medium acid; gradual, smooth boundary.

B3—32 to 48 inches, gritty clay loam, yellowish red (5YR 4/6) when dry and moist; weak, medium, subangular blocky structure; very hard when dry; firm when moist; few, fine, round, black concretions; slightly acid; gradual, smooth boundary.

C—48 to 70 inches, yellowish-brown (10YR 5/4) gritty light clay loam, dark yellowish brown (10YR 4/4) when moist; massive; hard when dry, friable when moist; slightly acid.

The Ap horizon ranges from very dark grayish brown to brown. Small stones commonly are scattered on the surface. Depth to the B horizon ranges from 14 to 22 inches. In some places the B horizon is gravelly clay loam. The C horizon ranges from light clay loam to light clay.

Morrill soils are browner than Shelby and Pawnee soils. They have a coarser textured subsoil than do the Pawnee soils. Morrill soils have colors similar to those of Gymer soils. Morrill soils contain glacial sand and gravel, whereas Gymer soils developed in Loveland loess lack the coarse sand and gravel.

Morrill clay loam, 3 to 8 percent slopes (Mm).—This soil occurs with Shelby and Pawnee clay loams. It has the profile described as typical for the Morrill series. Included with this soil in mapping were small areas of Shelby, Pawnee, and Gymer soils.

This Morrill soil is friable and easily worked, but erosion is the major hazard. If management provides practices for controlling erosion and maintaining tilth and fertility, all crops commonly grown in the county do well. Lime is needed for good growth of legumes. (Capability unit IIIe-1; Loamy Upland range site; woodland suitability group 3)

Morrill clay loam, 3 to 8 percent slopes, eroded (Mn).—This soil occurs with Shelby and Pawnee clay loams. Its surface layer has been thinned so much by erosion that it is mixed with subsoil material by normal tillage. In these eroded areas the surface layer has a reddish-brown cast. Gullies or gully scars are common in most areas. Included with this soil in mapping were areas of Shelby, Pawnee, and Martin soils.

This Morrill soil is suited to continuous cultivation, but practices are needed for controlling runoff and further erosion. Also needed are practices that improve soil tilth and fertility. (Capability unit IIIe–6; Loamy Upland range site; woodland suitability group 3)

Morrill clay loam, 8 to 12 percent slopes (Mo).—This strongly sloping soil occurs on uplands. It has a subsoil and substratum similar to those in the profile described as typical of the Morrill series, but depth to the subsoil is about 6 inches less in this soil. Surface runoff is medium to high. Included with this soil in mapping were areas of Shelby, Pawnee, and Martin soils.

This Morrill soil is mostly grassland. It is suitable for limited cultivation if practices for controlling erosion are adequate. Crops grow well where fertilizer is added. (Capability unit IVe–5; Loamy Upland range site; woodland suitability group 3)

Morrill-Gravelly land complex, 4 to 12 percent slopes (Mp).—In this complex small, scattered gravelly areas are so intermingled with areas of developed soils that it is not practical to map the gravelly areas or the soils separately. The gravelly areas have gravel within 15 inches of the surface. They make up about 20 to 40 percent of the complex, and Morrill soils make up most of the rest, but there are also areas of Shelby soils and a few small areas of Pawnee soils. The soils in this complex formed in glacial till on uplands. In some places, limestone crops out in narrow bands and large boulders occur. One of the two main areas of this complex occurs about 5 miles northeast of Rossville, and the other is 2 miles north of Dover.

Nearly all of this complex is rangeland. Native grasses are well suited. Plant roots penetrate the underlying gravelly layers because soil material fills the voids in the gravel. The soils in this complex produce good stands of mid and tall prairie grasses, such as big and little bluestem, side-oats grama, switchgrass, and indiangrass. Some parts of this complex are good sources of gravel suitable for road surfacing.

Management is needed that includes practices for maintaining good stands of grasses that provide grazing and help to control erosion. (Capability unit VIe–1; Loamy Upland range site; not assigned to a woodland suitability group)

Muir Series

The Muir series consists of nearly level, deep, well-drained, loamy soils that formed in alluvium. These soils occurs on high terraces, or benches, in the valley of the Kansas River.

In a typical profile the surface layer is medium acid, dark-gray silt loam about 8 inches thick. The subsoil extends to a depth of 62 inches. It is silt loam to a depth of 20 inches and silty clay loam below. Colors in the subsoil are dark gray, grayish brown, and light brownish gray. The underlying material is mildly alkaline, pale-brown silt loam.

Figure 6.—**Irrigated Muir silt loam.**

Muir soils are friable and easily worked. They take in a large amount of water that is available for plants. Crops respond well if proper amounts of fertilizer are added.

Muir soils are suited to the crops commonly grown in the county, and most of the acreage is cultivated. They are suitable for irrigation, and much of the irrigated acreage in the county occurs on these soils (fig. 6).

Typical profile of Muir silt loam (520 feet north, 100 feet east of the southwest corner of section 18, T. 11 S., R. 15 E.):

Ap—0 to 8 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak granular structure; slightly hard when dry, friable when moist; medium acid; clear boundary.

B1—8 to 20 inches, dark-gray (10YR 4/1) heavy silt loam, very dark gray (10YR 3/1) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; medium acid; gradual boundary.

B21—20 to 34 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist; slightly acid; diffuse boundary.

B22—34 to 49 inches, grayish-brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; slightly acid; gradual boundary.

B3—49 to 62 inches, light brownish-gray (10YR 6/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate to weak, fine, subangular blocky structure, massive in the lower part; hard when dry, friable when moist; slightly acid; gradual boundary.

C—62 to 80 inches, pale-brown (10YR 6/3) coarse silt loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, very friable when moist; mildly alkaline.

The Ap horizon ranges from 7 to 16 inches in thickness. The B horizon ranges from heavy loam to medium silty clay loam and is medium acid to neutral.

Muir soils are coarser textured than are Reading soils and have weaker structure. They are more clayey and darker colored than Eudora soils.

Muir silt loam (0 to 2 percent slopes) (Mr).—This is the only Muir soil mapped in the county. Included with this soil in mapping were small areas of Reading, Eudora, and Wabash soils.

Muir silt loam is used extensively for corn and other crops needed for feeding livestock. Growth of crops is good under dryland farming and can be increased substantially by irrigation if enough fertilizer is added. This soil has no management needs other than practices for maintaining fertility and tilth. (Capability unit I–1; Loamy Lowland range site; woodland suitability group 6)

Figure 7.—Profile of a Pawnee clay loam.

Pawnee Series

The Pawnee series consists of deep, well drained to moderately well drained soils that developed in glacial till. These soils are gently sloping to strongy sloping and occur on uplands, mostly in the northern and eastern parts of the county. Pawnee soils occupy the side slopes below Ladysmith soils on ridges and are also on ridges where Ladysmith soils do not occur.

In a typical profile the surface layer is very dark grayish-brown clay loam about 12 inches thick (fig. 7). The subsoil, about 36 inches thick, is very dark grayish-brown clay loam to a depth of 19 inches and below that depth is grayish-brown and light brownish-gray clay mottled with reddish brown or yellowish brown. The lower part contains many fine iron and manganese concretions and many glacial pebbles and sand grains. The underlying material is light brownish-gray clay that is mottled with light olive brown over mottled light-gray and light olive-brown clay.

These soils are well drained to moderately well drained. They have high moisture capacity and slow permeability. Crops on these soils respond well to additions of lime and fertilizer. Lime is particularly needed for legumes.

About 60 percent of the acreage is cultivated, and about 35 percent is used for range or pasture. The remaining 5 percent is wooded or is in some miscellaneous use. If adequately fertilized, these soils are suited to all crops commonly grown in the county.

Typical profile of Pawnee clay loam, 3 to 7 percent slopes (250 feet east, 150 feet south of the northwest corner of the southwest quarter of section 5, T. 10 S., R. 16 E.):

A1—0 to 12 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; medium acid; clear boundary.

B1—12 to 19 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist; fine glacial pebbles and sand common; medium acid; gradual boundary.

B21t—19 to 30 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; common, fine, reddish-brown and yellowish-brown mottles; moderate, medium, subangular blocky structure; very hard when dry, very firm when moist; distinct, continuous clay films; many sand grains and glacial pebbles; medium acid; gradual boundary.

B22t—30 to 36 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; common, fine, reddish-brown and yellowish-brown mottles; weak, medium and coarse, subangular blocky structure; very hard when dry, very firm when moist; many fine iron-manganese concretions; many sand grains and glacial pebbles; clay films are not so distinct as in the horizon above; slightly acid; diffuse boundary.

B3—36 to 48 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) when moist; common, coarse, distinct mottles of yellowish brown; weak, coarse, subangular blocky structure; very hard when dry; very firm when moist; thin and patchy clay films; iron-manganese concretions common; glacial sand grains and pebbles common; slightly acid; diffuse boundary.

C1—48 to 59 inches, light brownish-gray (10YR 6/2 light clay, grayish brown (10YR 5/2) when moist; common, medium, distinct mottles of light olive brown; mas-

sive; very hard when dry, very firm when moist; iron-manganese concretions common; neutral; diffuse boundary.

C2—59 to 79 inches, coarsely mottled light-gray and light olive-brown light clay; massive; very hard when dry, very firm when moist; neutral.

Depth to the B horizon ranges from 12 to 18 inches. Because the amount of glacial sand and pebbles in the clayey B2 horizon varies considerably, the clay is smooth or gritty. In many places concretions of calcium carbonate and pockets of soft segregated lime occur at a depth of more than 40 inches. In some places a few, thin, discontinuous stone lines are in the B or C horizon.

Pawnee soils have more clay in the subsoil than have Shelby and Morrill soils. Also, the varying amount of glacial sand and gravel in the Pawnee soils is lacking in the Martin and Ladysmith soils.

Pawnee clay loam, 0 to 3 percent slopes (Pa).—This soil occurs on ridgetops throughout the glaciated part of the county. Its surface layer commonly is 2 to 4 inches thinner than the surface layer in the profile described as typical for the Pawnee series.

Sorghums and soybeans grow better than corn on this Pawnee soil. Because erosion is a hazard on the longer slopes, practices are needed for controlling surface runoff. Also needed are practices for improving tilth and fertility. (Capability unit IIe-1; Loamy Upland range site; woodland suitability group 4)

Pawnee clay loam, 3 to 7 percent slopes (Pc).—This soil occupies areas below Ladysmith soils and Pawnee clay loam, 0 to 3 percent slopes. Its profile is the one described as typical for the Pawnee series. Included with this soil in mapping were small areas of Martin, Shelby, and Morrill soils.

Crops grow well on this Pawnee soil if management is used that slows runoff, reduces erosion, and maintains good tilth. Also needed are additions of fertilizer and lime. (Capability unit IIIe-3; Loamy Upland range site; woodland suitability group 4)

Pawnee clay loam, 3 to 7 percent slopes, eroded (Pe).—This soil occupies the same kinds of positions as does Pawnee clay loam, 3 to 7 percent slopes. Erosion has thinned the original surface layer so much that the plow layer consists of the remains of that layer mixed with a moderate amount of brownish subsoil material. In a few small areas, all of the original surface soil has been removed and there may be a few shallow gullies. Included with this soil in mapping were small eroded areas of Martin, Shelby, and Morrill soils.

This soil is better suited to small grains, legumes, and perennial grasses than it is to row crops. Use for row crops is limited. Practices are needed for controlling runoff and erosion and for improving tilth and fertility. Returning all crop residue to the soil is a way to add organic matter. Lime and fertilizer are needed for good crop growth. (Capability unit IIIe-5; Clay Upland range site; woodland suitability group 4)

Pawnee clay loam, 7 to 11 percent slopes (Pn).—This soil occurs on uplands. Its surface layer is 4 to 6 inches thinner than the one in the profile described as typical for the Pawnee series. Also, the subsoil of this soil is not so hard or firm as the subsoil in that profile. Included with this soil in mapping were a few small areas of Martin, Shelby, and Morrill soils.

Most of the acreage of this Pawnee soil is in native prairie grasses that are harvested for hay or are grazed. A few small areas are cultivated. Because erosion is a hazard, perennial grass is a better use than cultivated crops. If cultivated crops are grown, intensive practices are required for controlling erosion. (Capability unit IVe-3; Loamy Upland range site; woodland suitability group 4)

Reading Series

The Reading series consists of deep, well-drained, nearly level soils that are on terraces, or benches, along most streams in the county. These soils formed in moderately fine textured alluvium.

In a typical profile the surface layer is medium acid, dark grayish-brown silty clay loam about 14 inches thick. The subsoil extends to a depth of 56 inches and is silty clay loam throughout. It is dark brown to a depth of 40 inches and brown below that depth. The upper part is medium acid, but the lower part is slightly acid. The underlying material is neutral, yellowish-brown silty clay loam.

These soils have moderately slow permeability and high available moisture capacity. They are friable and easily worked. Reading soils are well supplied with organic matter and are high in fertility. They release moisture readily for plants and are seldom flooded.

Most of the acreage is cultivated, but a few areas remain in grass and trees. Reading soils are suited to all crops common in the county.

Typical profile of a Reading silty clay loam that has 0 to 2 percent slopes (1,200 feet east, 100 feet north of the southwest corner of the northwest quarter of section 35, T. 12 S., R. 13 E.):

A1—0 to 14 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; medium acid; gradual, smooth boundary.

B1—14 to 22 inches, dark-brown (10YR 4/3) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate to strong, fine, subangular blocky structure; hard when dry, firm when moist; dark, thin, patchy coatings on ped faces; medium acid; gradual, smooth boundary.

B2t—22 to 40 inches, dark-brown (10YR 4/3) heavy silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; dark, distinct, continuous coatings on ped faces; slightly acid; gradual, smooth boundary.

B3—40 to 56 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, fine, subangular blocky structure; hard when dry, firm when moist; dark, thin, patchy coatings on ped faces; slightly acid; diffuse boundary.

C—56 to 70 inches, yellowish-brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 4/4) when moist; massive; hard when dry, firm when moist; neutral.

The A horizon ranges from heavy silt loam to light silty clay loam. Depth to the B horizon ranges from 14 to 24 inches. In the B3 horizon angular blocky structure occurs in many places. In some places reddish-brown mottles occur below a depth of 40 inches. Reaction in the solum ranges from medium acid to slightly acid, and in the C horizon, from slightly acid to mildly alkaline.

Reading soils have stronger structure and are more clayey than Muir soils. They lack the reddish-brown colors of Gymer soils and are browner and less clayey than Wabash soils. Reading soils show more profile development than Kennebec soils and are not so susceptible to damaging floods.

Reading silty clay loam, 0 to 2 percent slopes (Re).—This is the only Reading soil mapped in Shawnee County. Included with this soil in mapping were small areas of Wabash, Muir, and Kennebec soils.

This Reading soil is among the best soils for farming in the county. Corn and other crops needed for livestock are grown extensively. Controlling erosion is not difficult. About the only practices needed are those that maintain soil tilth and fertility. Crops grow well in irrigated fields if an adequate supply of water is available. (Capability unit I–1; Loamy Lowland range site; woodland suitability group 6)

Riverwash

Riverwash (Rv) consists of an unstable accumulation of sandy and silty alluvium. It occurs as sandbars and islands along the Kansas River and is only slightly above the riverbed. The deposits change in size, depth, and other characteristics during each flood.

Riverwash is not suited to cultivated crops or pasture. Willows and cottonwoods are the native trees. In some areas trees probably will grow to fair size, but most of them will have little commercial value. (Capability unit VIIIs–1; not assigned to a range site or woodland suitability group)

Sarpy Series

The Sarpy series consists of deep, well-drained to somewhat excessively drained soils. These soils formed in moderately coarse textured to coarse textured alluvium adjacent to the Kansas River.

In a typical profile the surface layer is mildly alkaline, grayish-brown fine sandy loam about 7 inches thick. The subsurface layer is neutral, loose, grayish-brown loamy fine sand about 5 inches thick. The underlying material is neutral, pale brown to very pale brown fine sand.

Sarpy soils are very friable and easily worked. Natural fertility and available moisture capacity are low. Lime is generally not needed on these soils, but crops grow well if nitrogen and phosphate are added.

Except for areas of Sarpy sand, most of the acreage is cultivated, and some areas are in trees.

Typical profile of a Sarpy soil having a fine sandy loam surface layer (400 feet east, 30 feet north of the southwest corner of section 5, T. 11 S., R. 13 E.) in a cultivated field:

A1—0 to 7 inches, grayish-brown (10YR 5/2) light fine sandy loam, very dark grayish brown (10YR 3/2) when moist; single grain; soft when dry, very friable and slightly coherent when moist; noncalcareous: mildly alkaline; clear boundary.

AC—7 to 12 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; single grain; loose; neutral; clear boundary.

C1—12 to 20 inches, pale-brown (10YR 6/3) fine sand, dark brown (10YR 4/3) when moist; single grain; loose; neutral; clear boundary.

C2—20 to 66 inches, very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) when moist; single grain; loose; neutral.

The A horizon is mostly fine sandy loam, but it is loamy fine sand in a few areas. It is normally noncalcareous, but in places is calcareous for several years following major floods. Between depths of 10 and 40 inches are thin strata of fine sandy loam, loamy fine sand, fine sand, and silt loam. The average texture of these layers is loamy fine sand or fine sand. Reaction ranges from neutral to moderately alkaline. Sarpy soils are coarser textured than Eudora soils.

Sarpy sand (0 to 2 percent slopes) (Sa).—This nearly level to undulating soil occurs on the flood plain of the Kansas River, where most areas took form during the flood of 1951. Sarpy sand consists of stratified, light-colored, sandy alluvial material. The sand is mostly fine and medium and is intermingled with some pebbles. It extends to a depth of more than 20 inches, and in a few areas to more than 36 inches. Strata in the sand are generally silty, but in some places they are clayey. Most of these strata are less than 5 inches thick.

Sarpy sand is excessively drained and droughty. It contains very little organic matter, and available moisture capacity is very low. Reaction is neutral to mildly alkaline.

These sandy deposits are too thick for effective deep plowing. Most areas are abandoned for farming, and cottonwood trees generally take over these areas. Some of this sandy material is suitable as base material for concrete flooring. Sand blowing from these areas may damage adjacent cropland. (Capability unit VIs–1; Sandy Lowland range site; woodland suitability group 5)

Sarpy-Eudora complex, overwash (0 to 1 percent slopes) (Se).—This complex consists of well-drained to somewhat excessively drained soils. These soils formed in medium-textured to moderately coarse textured alluvium and occur on the flood plain of the Kansas River. The native vegetation was deciduous trees, mostly cottonwood, bur oak, green ash, American elm, and red elm.

This complex is made up of areas of Sarpy and Eudora soils that are so intermingled that it was not practical to map them separately. Where they are not protected by dikes, these soils are susceptible to occasional flooding. The areas were covered by pale-brown, mildly alkaline, fine- and medium-sized sand and loamy fine sand that were deposited by a flood in 1951. These deposits range from 6 to 30 inches in thickness. After the flood, many areas were plowed to a depth of 20 to 48 inches. Plowing destroyed normal stratification and mixed pockets of deposited sand with finer textured materials in the original soils. In areas that have been deep plowed, the plow layer is fine sandy loam or loamy fine sand.

The soils in this complex are friable, moderately fertile, and easily worked. Runoff is in small amounts because water passes rapidly through the profile. Soil blowing is likely in unprotected fields.

A few areas of these soils remain in trees, but most areas are used continuously for field crops. All crops common in the county can be grown. These soils are suitable for irrigation. (Both soils are in capability unit IIe–3 and the Sandy Lowland range site; Sarpy soils are in woodland group 5, and Eudora soils are in woodland group 6)

Sharpsburg Series

The Sharpsburg series consists of deep, well-drained soils that are gently sloping to sloping. These soils are

on uplands, mostly near the Kansas River. They formed in thin deposits of pale-brown loess underlain by reddish-brown loess or glacial till.

In a typical profile the surface layer is slightly acid, dark grayish-brown silty clay loam about 15 inches thick. The subsoil is also silty clay loam, and it extends to a depth of 44 inches. It is dark grayish brown to a depth of 23 inches and brown below that depth. In the lower part of the subsoil are clay films on most ped faces and in root channels. The underlying material is pale-brown and reddish-brown silty clay loam.

The Sharpsburg soils are fertile. Because the surface layer is friable and granular, it is easily worked. Crops respond well if lime, nitrogen, and phosphate are added. These soils hold large amounts of water that can be used by growing plants.

The native vegetation on Sharpsburg soils is tall prairie grasses. Most of the acreage is cultivated, and some areas are in pasture. These soils are suited to all crops commonly grown in the county.

Typical profile of Sharpsburg silty clay loam, 1 to 3 percent slopes (500 feet south, 500 feet east of northwest corner of the northeast quarter of section 1, T. 12 S., R. 16 E.) in a cultivated field:

A1—0 to 15 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

B1—15 to 23 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; thin patchy clay films in lower 4 inches; medium acid; gradual, smooth boundary.

B2t—23 to 37 inches, brown (10YR 5/3) heavy silty clay loam, dark brown (10YR 4/3) when moist; a few very dark grayish-brown (10YR 3/2) stains and streaks; moderate to strong, medium, subangular blocky structure; very hard when dry, firm when moist; clay films on most ped faces; medium acid; gradual, smooth boundary.

B3—37 to 44 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, prismatic and moderate, coarse, angular blocky structure; clay films on most ped faces and in root channels; hard when dry, friable when moist; a few dark stains and streaks in places; slightly acid; gradual, smooth boundary.

C—44 to 53 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; dark coatings on crevice walls; weak prismatic and weak, coarse, angular blocky structure; hard when dry, friable when moist; neutral; gradual, smooth boundary.

IIC—53 to 72 inches, reddish-brown (5YR 5/4) heavy silty clay loam, reddish brown (5YR 4/4) when moist; massive; hard when dry, friable when moist; neutral.

The A horizon generally is heavy silt loam to medium silty clay loam. The B horizon ranges from medium silty clay loam to light clay. In some places reddish-brown and yellowish-brown mottles occur in the lower B horizon and in the C horizon. The IIC horizon probably is Loveland loess.

Sharpsburg soils are not so brown as Gymer soils. They formed in deposits of loess, whereas Pawnee, Morrill, and Shelby soils developed in glacial till. The subsoil of Sharpsburg soils is less clayey than that of Ladysmith soils.

Sharpsburg silty clay loam, 1 to 3 percent slopes (Sg).—This soil occurs on ridgetops. It has the profile described as typical for the Sharpsburg series. Included with this soil in mapping were small areas of Gymer, Ladysmith, Pawnee, and Shelby soils.

All crops common in the county grow well on this Sharpsburg soil. Because runoff is medium and erosion is likely in cultivated areas, practices are needed to reduce loss of soils. Also needed are practices that maintain tilth and fertility. (Capability unit IIe–2; Loamy Upland range site; woodland suitability group 3)

Sharpsburg silty clay loam, 3 to 6 percent slopes (Sh).—This soil occupies the uplands adjacent to the alluvial plain of the Kansas River. The surface layer is about 5 inches thinner than the surface layer in the profile described as typical for the Sharpsburg series. Included with this soil in mapping were small areas of Martin, Shelby, and Pawnee soils.

Because this Sharpsburg soil is moderately susceptible to erosion, practices are needed for controlling surface runoff. Also needed are practices that maintain tilth and fertility. Crops respond well to additions of fertilizer. (Capability unit IIIe–1; Loamy Upland range site; woodland suitability group 3)

Shelby Series

The Shelby series consists of deep, well-drained soils that formed in glacial till. These soils are gently sloping to strongly sloping and are on uplands, mostly north of the Kansas River.

In a typical profile the surface layer is medium acid, very dark grayish-brown clay loam about 12 inches thick (fig. 8). The subsurface layer, about 5 inches thick, is medium acid, dark grayish-brown clay loam. The subsoil is medium acid clay loam about 27 inches thick. The upper part is brown, and the middle part is yellowish brown with common, fine, strong-brown and yellowish-brown mottles. The middle part also contains iron-manganese concretions. The lower part is pale brown with common, coarse, yellowish-brown mottles. It contains a few concretions of iron and manganese. The underlying material has mixed colors ranging from yellowish brown to light gray. It is slightly acid clay.

Shelby soils have moderately slow permeability. Runoff is medium where these soils are gently sloping and sloping and is rapid where the soils are strongly sloping. Shelby soils take in and release large amounts of water for plant growth. Response is good to adequate additions of fertilizer. Lime is needed for legumes.

The native vegetation was mid and tall prairie grasses. Most areas of gently sloping and sloping soils are cultivated, but some are in pasture. The strongly sloping soils are mostly in pasture, range, or hay.

Typical profile of Shelby clay loam, 3 to 8 percent slopes (800 feet north and 100 feet west of the southeast corner of section 8, T. 10 S., R. 16 E.) in an area of rangeland:

A1—0 to 12 inches, very dark grayish-brown (10YR 3/2) light clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

Figure 8.—**Typical profile of a Shelby clay loam to a depth of 40 inches.**

A3—12 to 17 inches, very dark grayish-brown and dark grayish-brown (10YR 3/2 and 4/2) clay loam, very dark brown and very dark grayish brown (10YR 2/2 and 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

B21t—17 to 22 inches, brown (10YR 5/3) medium clay loam, dark brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; thin, continuous clay films; medium acid; gradual, smooth boundary.

B22t—22 to 32 inches, yellowish-brown (10YR 5/4) medium to heavy clay loam, dark yellowish brown (10YR 4/4) when moist; moderate to weak, medium, subangular blocky structure; common, fine, strong-brown and yellowish-brown mottles; very hard when dry, firm when moist; thin, continuous clay films; fine ferromanganese concretions; medium acid; gradual, smooth boundary.

B3—32 to 44 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; weak, medium to coarse, subangular blocky structure; common, coarse, yellowish-brown mottles; very hard when dry, firm when moist; clay films mostly on vertical faces; few fine ferromanganese concretions; medium acid; gradual boundary.

C—44 to 80 inches, light clay that has mixed colors of yellowish brown, light yellowish brown, and light gray (10YR 5/8, 6/4, and 7/1); massive; very hard when dry, very firm when moist; slightly acid.

Some material from the B horizon appears to be mixed into the A3 horizon. The amount of glacial sand and gravel throughout the profile ranges from almost none to common. Pockets of very gravelly material occur in a few areas. In many places small streaks and pockets of soft, white lime occur at a depth greater than 40 inches. In some places Shelby soils on ridgetops are mantled by a thin deposit of loess.

Shelby soils are not so brown as Morrill and Gymer soils. Texture is coarser in Shelby soils than it is in the Pawnee and Martin soils.

Shelby clay loam, 1 to 3 percent slopes (Sk).—This soil normally occurs on ridgetops. Probably because of a thin mantle of loess over the glacial till, the surface layer of this soil is generally thicker than that in the profile described as typical for the Shelby series. Included with this soil in mapping were small areas of Pawnee soils.

If properly managed, this Shelby soil is suited to all crops commonly grown in the county. Practices are needed, however, for controlling erosion and maintaining tilth and fertility. (Capability unit IIe-2; Loamy Upland range site; woodland suitability group 3)

Shelby clay loam, 3 to 8 percent slopes (Sm).—This soil occurs below Pawnee or Ladysmith soils. The profile of this soil is the one described as typical for the Shelby series. Included with this soil in mapping were small areas of Pawnee, Morrill, Martin, and Elmont soils.

Although erosion is a hazard, this Shelby soil has only slight limitations to use for crops. Practices that adequately reduce loss of soil are needed. Turning under crop residue helps to maintain tilth. Crops respond well to additions of fertilizer. (Capability unit IIIe-1; Loamy Upland range site; woodland suitability group 3)

Shelby clay loam, 3 to 8 percent slopes, eroded (Sn).—The surface layer of this soil has been thinned by erosion, and ordinary tillage mixes subsoil material with the remains of the original surface layer. As a result, the surface layer of this soil is lighter colored than that in the profile described as typical for the Shelby series. In a few areas shallow gullies or gully scars are common.

The major hazard in cultivated areas is continued erosion. Practices are needed to control runoff and erosion and to improve soil tilth and fertility. This soil is best suited to small grains, legumes, and grasses. Use for row crops should be limited. (Capability unit IIIe-6; Loamy Upland range site; woodland suitability group 3)

Shelby clay loam, 8 to 12 percent slopes (So).—This soil occurs below the Pawnee and Ladysmith soils. The surface layer of this soil is thinner than the one in the profile described as typical for the Shelby series. Included with this soil in mapping were small areas of Martin, Morrill, and Elmont soils.

This Shelby soil is susceptible to severe erosion because it is strongly sloping and has rapid surface runoff. Pasture, range, and hay are the main uses. Small grains can be grown between the times perennial grasses and legumes are seeded, but row crops are not suited. Controlling runoff is the main requirement of management.

Returning crop residue to the soil is a good way to maintain tilth. (Capability unit IVe–5; Loamy Upland range site; woodland suitability group 3)

Shellabarger Series

The Shellabarger series consists of deep, dark, well-drained soils that are sloping to strongly sloping. These soils are on uplands near the town of Silver Lake. They formed in loamy eolian deposits on the south-facing slopes adjacent to the north side of the alluvial plain of the Kansas River.

In a typical profile the surface layer is slightly acid, dark-gray fine sandy loam about 12 inches thick. The subsurface layer is slightly acid, dark grayish-brown fine sandy loam about 7 inches thick. The subsoil extends to a depth of 42 inches, and it is slightly acid sandy clay loam. The subsoil is brown and dark brown to a depth of 27 inches and is brown below that depth. The underlying material is pale-brown fine sandy loam that has a few fine mottles.

Shellabarger soils are very friable. Runoff is medium to slow, permeability is moderate, and available moisture capacity is medium. Because slopes are strong, these soils are susceptible to erosion.

The native vegetation is mid and tall prairie grasses. Most of the acreage is in tame grass pasture, but some is cultivated, and a few areas remain in native grasses. If protected from erosion, these soils are suited to all crops commonly grown in the county.

Typical profile of Shellabarger fine sandy loam, 3 to 8 percent slopes (450 feet east, 100 feet north of the southwest corner of section 34, T. 10 S., R. 14 E.) in a cultivated field:

A1—0 to 12 inches, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) when moist; weak, medium, granular structure; slightly hard when dry, very friable when moist; slightly acid; gradual, smooth boundary.

A3—12 to 19 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure that breaks readily to weak, fine, granular structure; slightly hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

B21t—19 to 27 inches, brown (7.5YR 5/4) and dark-brown (7.5YR 4/2) light sandy clay loam, dark brown (7.5YR 3/2, 4/3) when moist; weak, fine and medium, subangular blocky structure; hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

B22t—27 to 42 inches, brown (7.5YR 5/4) light sandy clay loam, dark brown (7.5YR 4/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

C—42 to 76 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; few, fine, faint, brownish mottles; massive; hard when dry, very friable when moist; neutral.

In most places the A horizon is fine sandy loam, but it is loam in some areas. Depth to the B horizon ranges from 12 to 24 inches. The solum is medium acid or slightly acid, and the C horizon is slightly acid or neutral.

Shellabarger soils contain less clay than Shelby and Morrill soils. They lack the grayish subsurface layer that is in Konawa soils. Shellabarger soils are sandier than Shelby, Morrill, and Gymer soils.

Shellabarger fine sandy loam, 3 to 8 percent slopes (Sp).—This soil occurs on uplands. It has the profile described as typical for the series. Included with this soil in mapping were small areas of Shelby, Morrill, and Gymer soils.

This Shellabarger soil can be used for cultivated crops, but perennial grasses are better suited because erosion is a hazard. Also needed are other practices for controlling erosion, along with management for maintaining or improving fertility. (Capability unit IIIe–4; Sandy range site; woodland suitability group 8)

Shellabarger fine sandy loam, 3 to 8 percent slopes, eroded (Sr).—This soil is in fields that have been cultivated or are now cultivated. The surface layer has been eroded so much that ordinary tillage mixes the remains of the surface layer with part of the subsoil. As a result, the surface layer is browner than the one in the profile described as typical for the series. In many places uncrossable gullies or gully scars are a part of the acreage.

Included with this soil in mapping were small areas of Morrill, Shelby, and Gymer soils.

This Shellabarger soil is well suited to perennial grasses for hay or pasture, but use for cultivated crops should be limited to close-growing crops, such as small grains, legumes, and grasses. The main management requirements are controlling erosion and maintaining fertility. Returning crop residue to the soil is a good way to improve soil tilth. Crops respond well to applications of fertilizer. (Capability unit IVe–4; Sandy range site; woodland suitability group 8)

Shellabarger fine sandy loam, 8 to 12 percent slopes (Ss).—The surface layer and subsurface layer of this soil are not so thick as those in the profile described as typical for the Shellabarger series.

This soil occurs with Morrill, Shelby, and Gymer soils, and included with it in mapping were small areas of those soils.

Most of this Shellabarger soil is in perennial grasses and is used for range or pasture. Because the hazard of erosion is very severe, this soil is not suitable for cultivation. (Capability unit VIe–1; Sandy range site; woodland suitability group 8)

Sibleyville Series

The Sibleyville series consists of moderately deep, well-drained soils that are sloping to strongly sloping. These soils occur on uplands in small areas throughout the county. They formed in material weathered from sandstone or sandy shale.

In a typical profile the surface layer is medium acid, dark grayish-brown loam about 8 inches thick (fig. 9). The subsurface layer is strongly acid, dark grayish-brown loam about 6 inches thick. The subsoil is strongly acid, dark-brown and brown sandy clay loam that extends to a depth of 34 inches. The underlying material is strongly acid, strong-brown fine sandy loam that overlies sandstone bedrock at a depth of about 38 inches.

Sibleyville soils are very friable and erode easily. They are moderately permeable. Available moisture capacity is medium to low. Organic-matter content is moderately low.

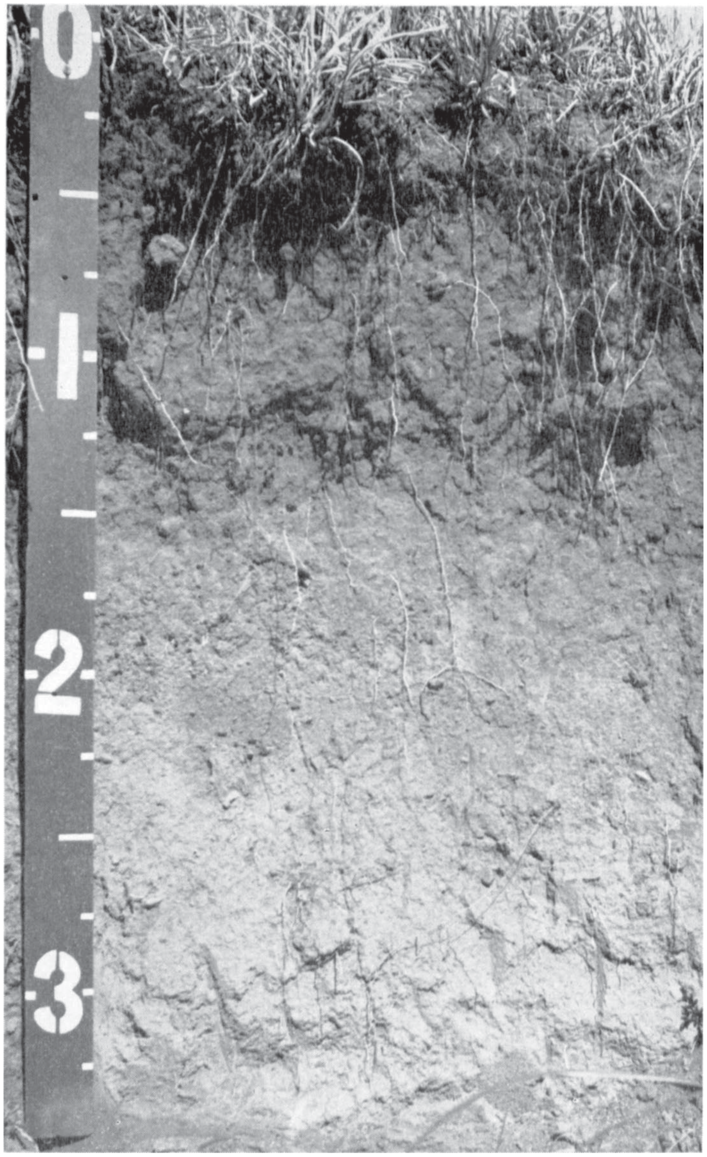

Figure 9.—Profile of a Sibleyville loam.

Sibleyville soils are used about equally for cultivated crops and for range or pasture. The native vegetation is mixed mid and tall prairie grasses. Grain sorghum, small grains, and perennial grasses are suitable crops, but corn does not grow well on these soils.

Typical profile of Sibleyville loam, 3 to 7 percent slopes (1,250 feet south, 75 feet east of the northwest corner of section 29, T. 12 S., R. 14 E.) in native grass:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) light loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; hard when dry, very friable when moist; medium acid; gradual boundary.

AB—8 to 14 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; weak, fine, subangular blocky structure; hard when dry, friable when moist; strongly acid; gradual boundary.

B2t—14 to 19 inches, dark-brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; strongly acid; gradual boundary.

B3—19 to 34 inches, brown (10YR 5/3) light sandy clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; strongly acid; gradual boundary.

C—34 to 38 inches, strong-brown (7.5YR 5/6) fine sandy loam, strong brown (7.5YR 4/6) when moist; massive; hard when dry, friable when moist; weathered sandstone fragments are common and increase in number as depth increases; strongly acid.

R—38 inches, sandstone.

In some places the A horizon is fine sandy loam. Depth to sandstone or shale ranges from 20 to 40 inches. Reaction throughout the profile is medium acid to strongly acid.

Silbleyville soils are coarser textured throughout the profile than Vinland and Elmont soils. They are not so deep to the underlying shale as Elmont soils. Sibleyville soils formed in material weathered from sandstone or sandy shale, whereas Konawa and Shellabarger soils formed in deep loamy alluvial and eolian deposits.

Sibleyville loam, 3 to 7 percent slopes (St).—This soil is in small areas throughout the county. Its profile is the one described as typical for the Sibleyville series. Included with this soil in mapping were small areas of Elmont and Vinland soils.

All crops common in the county are suited to this Sibleyville soil, but corn and alfalfa are less suited than other crops. Practices are needed for controlling erosion, which is the main hazard. Also needed are practices that add crop residue to the soil and that improve fertility. (Capability unit IVe–2; Loamy Upland range site; woodland suitability group 7)

Sibleyville loam, 7 to 11 percent slopes (Su).—This soil occurs in small areas in all parts of the county. The surface layer and subsurface layer combined are about 4 inches thinner than those in the profile described as typical for the Sibleyville series. Included with this soil in mapping were small areas of Elmont and Vinland soils.

Because erosion is the main hazard, this Sibleyville soil is not suitable for cultivation, though it is suited to perennial grasses in pasture, range, or hayland. Practices are needed for reducing loss of soil and improving fertility. (Capability unit VIe–1; Loamy Upland range site; woodland suitability group 7)

Sogn Series

The Sogn series consists of very shallow, moderately well drained to somewhat excessively drained soils that formed over limestone. These soils are sloping to steep, and they occur on uplands in all parts of the county.

In a typical profile the surface layer is very dark grayish-brown silty clay loam 10 inches thick. It is neutral in the upper part and mildly alkaline in the lower part. The lower part of the surface layer rests directly on the limestone and commonly contains fragments of limestone.

The Sogn soils have all essential plant nutrients, but these soils are very shallow to limestone and their available moisture capacity is restricted. In many areas where the limestone is broken and shattered, it is penetrated by roots. Runoff is rapid on these soils.

These soils are not suitable for cultivation. Most areas are used for pasture or range, but a few areas are woodland. Needed on these soils is a permanent vegetative cover. Overgrazing decreases growth of plants, eliminates the better grasses, and encourages serious water erosion.

Typical profile of a Sogn soil that has a silty clay loam surface layer (200 feet west, 170 feet north of the southeast corner of the southwest quarter of section 31, T. 13 S., R. 16 E.):

A11—0 to 3 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; neutral; clear boundary.

A12—3 to 10 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, subangular blocky structure; very hard when dry, firm when moist; noncalcareous; mildly alkaline; abrupt boundary.

R—10 inches, grayish-brown limestone.

The A horizon ranges from very dark gray to brown. The limestone ranges from thick, massive layers to thin, broken ledges that are interbedded with shale and clay. Outcrops of limestone are common.

Sogn soils developed from weathered limestone, whereas Vinland and Kipson soils developed from weathered interbedded shale. Sogn soils are not so deep as the Labette, Martin, and Elmont soils.

Sogn-Vinland complex (3 to 25 percent slopes) (Sv).—This complex consists of moderately well drained to somewhat excessively drained soils that formed from interbedded shale and limestone. It occurs in all parts of the county.

About 40 to 75 percent of this complex is Sogn soils, about 20 to 50 percent is Vinland soils, and the rest consists mostly of Martin, Labette, and Elmont soils and of Stony steep land. Outcrops of limestone are common. The soils in this complex are so intermingled that it is not practical to map them separately.

Because of the slopes and the hazard of erosion, the soils in this complex are not suited to cultivated crops. They are better suited to native grasses. A few areas are wooded. Good practices of grazing management are needed to maintain a vegetative cover that is adequate in controlling erosion. (Both soils are in capability unit VIe–2; Sogn soils are in the Shallow range site and Vinland soils are in the Loamy Upland range site; neither kind of soil assigned to a woodland suitability group)

Stony Steep Land

Stony steep land (15 to 45 percent slopes) (Sw) occurs on uplands throughout the county. It consists of very shallow soils intermingled with deeper soils and limestone outcrops.

In this land type stony land makes up 15 to 50 percent of the acreage; shallow soils, 5 to 20 percent; and deep and moderately deep soils, 40 to 70 percent. In the deep and moderately deep soils, the soil material resembles that of the Martin and Labette soils. Limestone outcrops are prominent in this land type.

Stony steep land has rapid runoff and is excessively drained. The shallow soils have low available moisture capacity and are droughty. The deeper soils have medium to high available moisture capacity.

This land is mostly range, but a few areas are wooded. None of the acreage is suited to cultivated crops. The native vegetation is mostly mid and tall prairie grasses, such as side-oats grama, little bluestem, big bluestem, indiangrass, and switchgrass. Because this land is rough, much of it is not readily accessible for grazing by livestock. Management is needed to maintain a good stand of native grasses. (Capability unit VIIe–1; Breaks range site; woodland suitability group not assigned)

Vinland Series

The Vinland series consists of sloping to strongly sloping, well-drained, shallow soils that formed in material weathered from noncalcareous interbedded silty, sandy, and clayey shale. These soils are on uplands in all parts of the county.

In a typical profile the surface layer is medium acid to slightly acid, grayish-brown silty clay loam about 6 inches thick. It is underlain by medium acid, brown silty clay loam that contains many fragments of shale. At a depth of 15 inches is noncalcareous, reddish-brown and light-gray, interbedded silty and sandy shale and clay beds (fig. 10). The shale is partly weathered and cracked to a depth of 36 inches.

Surface runoff is medium to rapid. Permeability is moderately slow. Internal drainage is restricted by the underlying shale. These soils are somewhat droughty, because available moisture capacity is medium to low.

Most of the acreage of Vinland soils is in native prairie grasses that are used for hay or grazing. These soils are not suitable for cultivation, but a few small areas are cultivated. These soils have a good supply of essential plant nutrients and support good stands of prairie grasses under proper management.

Typical profile of Vinland silty clay loam (250 feet south, 160 feet west of the northeast corner of the southeast quarter of section 6, T. 13 S., R. 14 E.):

A1—0 to 6 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, firm when moist; medium acid to slightly acid; gradual boundary.

C—6 to 15 inches, brown (10YR 5/3) channery silty clay loam, dark brown (10YR 4/3) when moist; moderate, very fine, subangular blocky structure; hard when dry, firm when moist; medium acid; clear boundary.

R—15 to 36 inches, reddish-brown and light-gray interbedded silty and sandy shales and clay beds.

The A horizon ranges from very dark gray to brown. It is medium acid to neutral. Colors in the C horizon are quite variable and range from dark gray to light yellowish brown. The C horizon is medium acid to mildly alkaline. Depth to the underlying shale ranges from 8 to 20 inches. All shale and clay in the R horizon are noncalcareous.

Vinland soils are not so deep as Elmont and Martin soils. Shale underlies Vinland soils, but Sogn soils are underlain by limestone, which crops out in some places.

Vinland silty clay loam (4 to 10 percent slopes) (Vn).—This is the only Vinland soil mapped in the county. It is suited only to perennial grasses. Areas that have been cultivated are usually eroded in most places and should be seeded to perennial grasses. Large additions of fer-

Figure 10.—**Profile of Vinland silty clay loam showing shale at a shallow depth.**

tilizer are needed to obtain a vigorous growth of tame grasses in cultivated areas. (Capability unit VIe–1; Loamy Upland range site; not assigned to a woodland suitability group)

Wabash Series

The Wabash series consists of deep, nearly level, dark-colored soils that formed in fine-textured alluvium on the bottom lands along all major streams in the county. These soils are subject to occasional flooding from streams, and water also runs in from adjacent uplands.

In a typical profile the surface layer is about 24 inches thick and consists of slightly acid silty clay. The next layer is dark-gray silty clay that extends to a depth of 60 inches. The underlying material is mildly alkaline, gray silty clay.

These soils are moderately well drained to somewhat poorly drained. They dry slowly following rains, and because water remains on the surface, are often difficult to till.

Most of the acreage of Wabash soils is cultivated, but a few areas are in trees. All crops commonly grown in the county are suited to the Wabash soils, but soybeans and grain and forage sorghums are the most suitable crops. Corn and wheat are not so well suited as other crops. Alfalfa will not survive in most years, unless the fields are adequately drained. Prairie cordgrass and gamagrass are the common perennial grasses. Smartweeds are common in cultivated fields.

Typical profile of Wabash silty clay (1,000 feet south, 100 feet west of the northeast corner of the southeast quarter of section 7, T. 11 S., R. 15 E.) in a cultivated field:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; weak, very fine, subangular blocky structure; very hard when dry, firm when moist, slightly sticky and plastic when wet; slightly acid; clear boundary.

A1—7 to 24 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; more clay in horizon than in horizon above; weak, fine, subangular blocky structure; extremely hard when dry, very firm when moist, slightly sticky and plastic when wet; slightly acid; diffuse boundary.

AC—24 to 60 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; massive or very weak subangular blocky structure; extremely hard when dry, very firm when moist, slightly sticky and plastic when wet; slightly acid; diffuse boundary.

C—60 to 72 inches, gray (10YR 5/1) silty clay, dark gray (10YR 4/1) when moist; massive; extremely hard when dry, very firm when moist, slightly sticky and plastic when wet; few small concretions of iron-manganese and of calcium carbonate; noncalcareous; mildly alkaline.

The A horizon ranges from silty clay loam to silty clay. Depth to mottling is greater than 20 inches. In some places mottles occur in the AC and C horizons and range from faint to distinct and from very few to common. Depth to lighter colored material ranges from 40 to 60 inches. In some places a few calcium carbonate concretions occur below a depth of 40 inches.

Wabash soils are finer textured than the Reading and Kennebec soils and are not so well drained.

Wabash silty clay (0 to 1 percent slopes) (Wa).—This soil generally occurs in the slack-water areas of the alluvial plains along the major streams in the county. Its profile is the one described as typical for the Wabash series. Included with this soil in mapping were small areas of Wabash silty clay loam.

In Wabash silty clay, deep cracks 1 to 3 inches wide form during dry weather, especially in alfalfa fields. This soil is not easily worked. It is sticky and plastic if worked when too wet and is hard if worked when too dry. Runoff is slow, and permeability is very slow.

If this soil is cultivated, adequate drainage is needed (fig. 11). Wetness is the main limitation to use. (Capability unit IIIw–1; Clay Lowland range site; woodland suitability group 2)

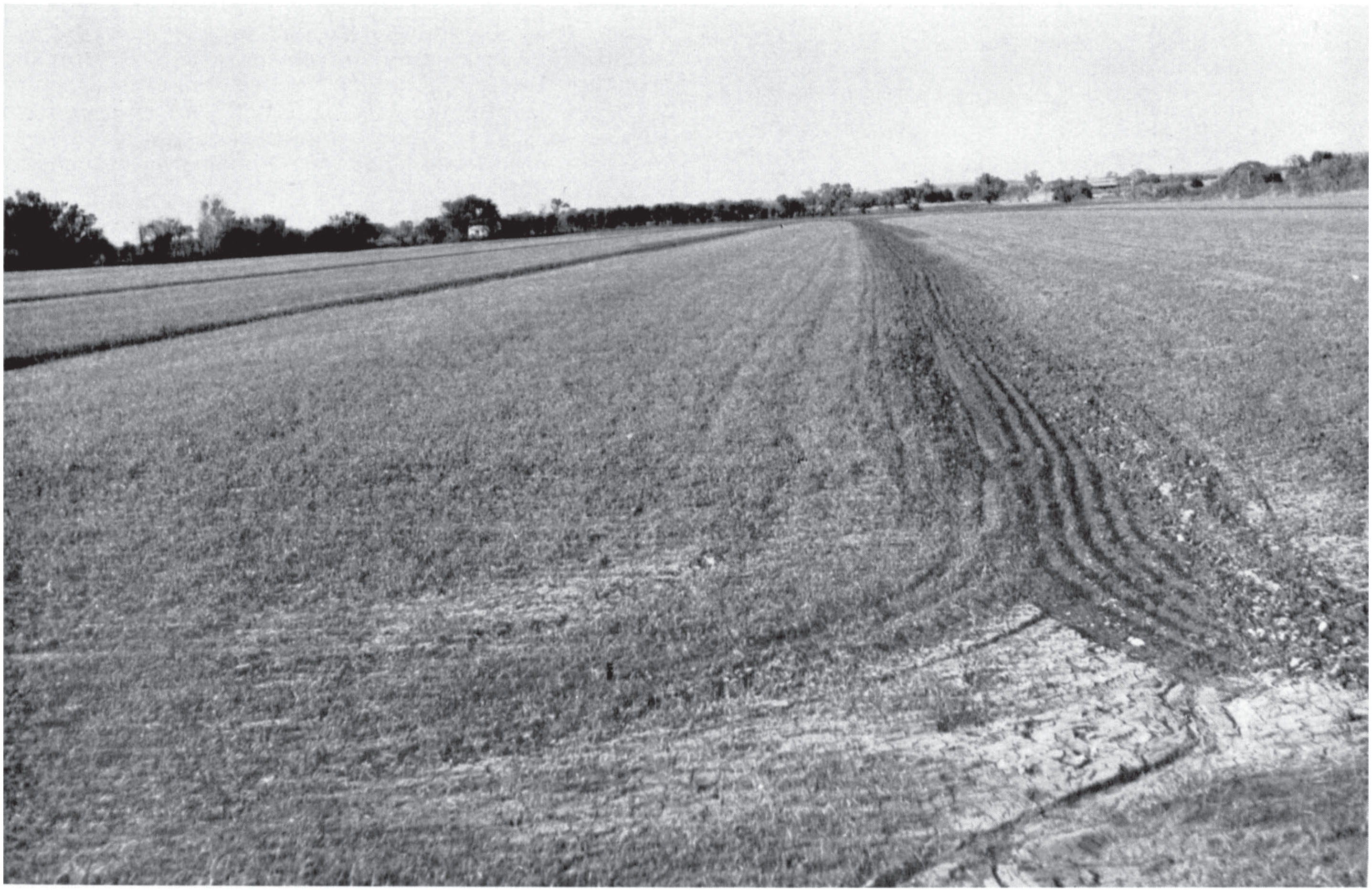

Figure 11.—**A bedding system provides drainage on Wabash silty clay.**

Wabash silty clay loam (0 to 1 percent slopes) (Wb).—Except that its surface layer is silty clay loam instead of silty clay, this soil has a profile similar to the one described as typical for the Wabash series. Included with this soil in mapping were small areas of Reading and Kennebec soils and of Wabash silty clay.

Available moisture capacity is high for this Wabash soil. Flooding is sometimes a hazard in local areas. The main management requirement is maintaining soil fertility and tilth. (Capability unit IIw-1; Clay Lowland range site; woodland suitability group 2)

Welda Series

The Welda series consists of deep, sloping to strongly sloping, well-drained soils on uplands adjacent to the alluvial plain of the Kansas River. In Shawnee County these soils occur only on the south side of the Kansas River and east of Tecumseh. They developed in Loveland loess.

In a typical profile the surface layer is slightly acid, grayish-brown silt loam about 9 inches thick. The subsurface layer is strongly acid, light brownish-gray silt loam about 3 inches thick. It contains a few browner peds of a finer texture. The subsoil extends to a depth of 60 inches. It is reddish-brown silty clay, and it is strongly acid in the upper part and medium acid in the lower part. The underlying material is slightly acid, light reddish-brown silty clay loam.

The Welda soils have medium to rapid runoff and medium to high available moisture capacity. Crops on these soils respond well to additions of lime and fertilizer.

The Welda soils are used about equally for cropland, pasture, and woodland. The native vegetation consisted of trees, chiefly elm, oak, and hickory, and of tall prairie grasses.

Typical profile of Welda silt loam, 4 to 10 percent slopes (500 feet north, 40 feet east of the southwest corner of the northeast quarter of section 33, T. 11 S., R. 17 E.) in woodland:

A1—0 to 9 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; slightly acid; clear boundary.

A2—9 to 12 inches, light brownish-gray (10YR 6/2) silt loam, horizon has a few brown peds finer textured than silt loam, dark grayish brown (10YR 4/2) when moist; moderate to weak, fine, subangular blocky structure; slightly hard when dry, friable when moist; strongly acid; clear, smooth boundary.

B2t—12 to 30 inches, reddish-brown (5YR 5/4) light silty clay, reddish brown (5YR 4/4) when moist; moderate, fine, subangular and angular blocky structure; clay films on some ped faces and in root channels; very hard when dry, firm when moist; strongly acid; diffuse boundary.

B3—30 to 60 inches, reddish-brown (5YR 5/4) light silty clay, reddish brown (5YR 4/4) when moist; weak, medium and fine, subangular blocky structure; some angular blocky peds; clay films on some ped faces; very hard when dry, firm when moist; medium acid; diffuse boundary.

C—60 to 72 inches, light reddish-brown (5YR 6/4) silty clay loam, reddish brown (5YR 5/4) when moist; massive; very hard when dry, firm when moist; some clay films in the root channels; slightly acid.

Color of the A horizon ranges from dark brown to light brownish gray. The A2 horizon ranges from 2 to 5 inches in thickness. In cultivated fields this horizon is destroyed because plowing has mixed the A2 layer with the surface layer. The B horizon is medium acid or strongly acid and ranges from medium silty clay loam to light silty clay. Structure tends to be prismatic in some areas.

Welda soils are finer textured than the Konawa soils and have a lighter colored surface layer than the Gymer soils.

Welda silt loam, 4 to 10 percent slopes (We).—The profile of this soil is the one described as typical for the Welda series. Included with this soil in mapping were small areas of Gymer silt loam, 3 to 8 percent slopes. Also included were areas of a soil developed in Peorian silts.

This Welda silt loam is suited to all crops commonly grown in the county. Because erosion is a hazard, practices are needed to reduce runoff. This soil is acid and requires lime if legumes are grown. Crops respond well if enough fertilizer is added. (Capability unit IIIe–3; Savannah range site; woodland suitability group 3)

Use and Management of Soils

The soils of Shawnee County are used mainly for growing crops and to a lesser extent for grazing. This section explains how the soils in the county may be managed for these purposes and also for woodland and wildlife. The section also tells how the soils can be used for building roads and other engineering structures and as recreational sites. A table in this section lists predicted yields of the principal nonirrigated crops for the soils in the county that are generally used for the crops.

Management of Soils Used as Cropland [3]

If suitable uses are selected for the soils of Shawnee County, and the soils are managed properly, crops will continue to grow well for long periods. In cultivated fields improved practices of management are essential for reducing the loss of organic matter. A good supply of organic matter is important because it improves soil structure, increases permeability, and helps to reduce erosion.

To conserve cultivated soils, it is necessary to use management that includes a suitable cropping system, minimum tillage, and good use of fertilizer so that a large amount of crop residue is produced and returned to the soils. In addition to the crop residue, animal manure also helps maintain or improve soil tilth and structure. Terracing, contour farming, and grassed waterways are helpful in reducing runoff and erosion from sloping soils on uplands. Drainage is essential on some soils of the bottom lands. Good management consists of a combination of these practices.

The crops most common in Shawnee County are corn, grain and forage sorghums, small grains, soybeans, alfalfa, sweetclover, red clover, and bromegrass. These crops respond well when commercial fertilizer, manure, and lime are added to the soils. The kind and amount of fertilizer to use on each crop is determined by field trials and soil tests.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The classification does not apply to most horticultural crops, or to other crops that have their own special requirements. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest grouping, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. Classes are defined as follows:

Class I. Soils have few limitations that restrict their use.

Class II. Soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III. Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV. Soils have very severe limitations that restrict the choice of plants, require careful management, or both.

Class V. Soils subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils have severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms have limitations that preclude their use for commercial plant

[3] Earl J. Bondy, conservation agronomist, Soil Conservation Service, assisted in writing this subsection.

production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

Capability Subclasses are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in some parts of the United States but not in Shawnee County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-3 or IIIe-1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability units

A capability unit is made up of soils that have about the same limitations to use and susceptibility to damage and that need about the same management. In the following pages each capability unit in the county is described, and management for each is suggested. The mention of the soil series represented in a unit does not mean that all the soils in the series are in the unit. The soils in each capability unit can be found by referring to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1

This unit consists of deep, nearly level, well-drained soils in alluvium. These soils are not subject to damaging overflow. They are in the Muir, Eudora, and Reading series.

These soils are easy to work. They store large amounts of moisture that are readily available to growing plants. Erosion is not a problem. These soils are well supplied with plant nutrients, or they respond well to additions of fertilizer. The chief management needs are those practices that maintain organic matter, fertility, and soil tilth.

All field crops common in the county grow well on these soils. Truck crops, Irish potatoes, and nursery stock also grow well. These soils are also suited to grasses and trees, and they can be developed as wildlife habitat.

These soils are well suited to irrigation. Corn, grain and forage sorghums, soybeans, alfalfa, milo, vegetables, and nursery stock respond well if irrigation water is applied properly (fig. 12). Fertility and tilth can be maintained or improved by returning crop residue to the soil and applying fertilizer as needed.

Engineering and agronomic practices are needed to help conserve irrigation water and use it efficiently. Land leveling is commonly needed. The crop rotations that are suitable under dryland farming are also suitable under irrigation.

CAPABILITY UNIT IIe-1

The soils in this unit consist of deep, gently sloping, well drained and moderately well drained silty clay loams and clay loams on uplands. These soils have a hard or firm clay subsoil. They developed in residuum from limestone and shale and from glacial material. They are in the Labette, Martin, and Pawnee series.

These soils are fairly easy to cultivate and are fertile. The available moisture capacity is high, and permeability is slow. Organic-matter content is moderately high. The chief management needs are those practices that maintain soil tilth and help to control erosion.

The soils in this unit are suited to all crops commonly grown in the county. On these soils tame and native perennial grasses are also suitable, and trees in farmstead windbreaks grow well.

Organic matter and soil tilth can be maintained by returning all crop residue to the soil and adding manure. Terraces and contour farming are necessary in some fields to help control water erosion.

CAPABILITY UNIT IIe-2

This unit consists of deep, well-drained, gently sloping loamy soils on uplands. These soils have a moderately fine textured subsoil. They are in the Sharpsburg and Shelby series.

These soils are fertile, friable, and easy to cultivate. They store large amounts of moisture and release it readily to growing plants. Permeability is moderately slow, and surface runoff is medium. Cultivated fields are only slightly eroded. Organic-matter content is high. The chief management needs are practices for maintaining soil tilth and fertility and for controlling erosion.

These soils are suited to all crops commonly grown in the county. Tame and native perennial grasses and trees for farmstead windbreaks also grow well.

Terraces and contour farming help to control runoff. Returning all crop residue to the soil helps to maintain the organic-matter content and soil tilth.

CAPABILITY UNIT IIe-3

The soils in this unit are deep, sandy, and loamy. They are nearly level on first bottoms of the Kansas River and are gently sloping on alluvial fans at the edge of the river's alluvial plain. In this unit are a sandy variant of the Eudora series and Sarpy and Eudora soils mapped in a complex.

These soils have low capacity for storing moisture that growing crops can use. The organic-matter content and

***Figure 12.*—Milo on Eudora silt loam responds well to the proper application of irrigation water.**

the supply of plant nutrients are also low. Soil blowing is a hazard in cultivated areas.

The soils in this unit are suited to all crops commonly grown in the county. On these soils melons and vegetables grow well. In most years, however, growth of crops is not uniform, because these soils vary from place to place. These soils are also suited to trees.

Proper management of crop residue will help to prevent soil blowing and to maintain soil tilth and fertility. All crop residue and stubble mulching should be used. Applications of lime are not needed, for these soils are mildly alkaline to neutral.

These soils are suitable for irrigation. All irrigated field crops and vegetable crops grow well. Corn and alfalfa are the main crops.

If these soils are irrigated, they need frequent applications of water because they have low available moisture capacity. Avoiding excessive irrigation is important, however, because too much water tends to leach out plant nutrients. Land leveling is essential to conserve irrigation water or to make more efficient use of it. Proper use of commercial fertilizer, such as nitrogen and phosphate, and turning under all available crop residue are essential for maintaining soil fertility. Also, additions of manure are helpful.

CAPABILITY UNIT IIs-1

Ladysmith silty clay loam, 0 to 1 percent slopes, is the only soil in this capability unit. This deep, nearly level soil occurs on uplands.

The soil in this unit has a tight clay subsoil that slowly releases water to plants. Permeability is slow to very slow, but water erosion presents little danger. Crops, however, may be damaged by too much moisture during periods of excessive precipitation. During spring in some years, soil blowing is likely in fields that have been plowed in fall and left unprotected. The main practices needed on this soil are those that maintain organic matter and fertility and that improve tilth.

These soils are well suited to wheat, grain and forage sorghums, soybeans, sweetclover, red clover, and alfalfa. Corn is sometimes damaged during short periods of hot, dry weather.

Returning all crop residue to the soil is helpful in maintaining soil tilth and fertility. Planting deep-rooted legumes at regular intervals is also important because

this practice increases permeability in the subsoil. Crops grown on this soil respond well to additions of lime and fertilizer.

CAPABILITY UNIT IIw-1

In this unit are deep, nearly level soils that are clayey and loamy. These soils are well drained to somewhat poorly drained. They are on bottom lands and are subject to occasional flooding by water running in from adjacent uplands. These soils are in the Eudora, Kimo, and Wabash series. The Kimo and Wabash soils have a few slight depressions.

The soils in this unit are fertile and fairly easy to work. Available moisture capacity is high, and permeability is moderate to slow. Organic-matter content is high. The main practices needed are those that maintain organic matter and fertility and that protect the soils from runoff. Also needed are practices for disposing of excess water.

All crops commonly grown in the county are suitable. In a few small areas crops, especially corn and alfalfa, are sometimes damaged by too much moisture, unless surface drainage is adequate.

These soils are suited to tame and native grasses and to trees. They also are suitable as wildlife habitat.

Returning all crop residue to the soil helps to maintain good soil tilth. In some fields land leveling or drainage ditches are needed to keep water from standing in the slight depressions. Diversion terraces are needed in some places to protect the soil from runoff from higher areas. Crop growth can be increased by applying fertilizer and lime.

These soils are suitable for irrigation. The main irrigated crops are corn, alfalfa, vegetables, and nursery stock. In most places land leveling is needed for efficient use of irrigation water or for drainage. Fertility and tilth can be maintained or improved by including a deep-rooted legume in the cropping sequence and returning all crop residue to the soil. Also important is applying fertilizer so that the most efficient use of irrigation water is made and crop growth is increased.

CAPABILITY UNIT IIw-2

This unit consists of deep, well-drained loamy soils in the Kennebec series. These soils are on bottom lands and are subject to occasional flooding unless they are protected by levees.

These soils are easy to cultivate and are high in fertility. They have moderate permeability and high available water capacity. Organic-matter content is high. The major hazard is damage to crops by floods.

These soils are suited to all crops commonly grown in the county. They are also suited to tame and native grasses and to trees, and they can be developed as wildlife habitat. Continuous corn and grain sorghum are suitable crops if all crop residue is returned to the soil and the proper kinds and amounts of fertilizer are added. Providing protection from flooding generally is not feasible.

These soils are suitable for sprinkler irrigation. Because flooding is likely, land leveling generally is not feasible. Corn, grain and forage sorghums, soybeans, alfalfa, and tame grasses grow well in irrigated areas. The crop rotations that are suitable under dryland farming are also suitable under irrigation, but more fertilizer should be added in irrigated areas.

CAPABILITY UNIT IIIe-1

In this unit are deep, well-drained, sloping soils that have a clayey and loamy subsoil. These soils are in the Eudora, Gymer, Morrill, Sharpsburg, and Shelby series. All of the soils in this capability unit are on uplands, except the Eudora soils, 6 to 12 percent slopes, eroded. The Eudora soils are on the short slopes between benches, or levels, of the bottom lands.

The soils in this unit are fertile, friable, and easy to work. They store large amounts of moisture and release it readily to plants. The chief management needs are practices that control erosion and maintain soil tilth and fertility.

These soils are suited to all cultivated crops commonly grown in the county. They are also well suited to tame and native grasses and trees.

Contour farming and terraces are suitable for cultivated fields of all the soils in this capability unit except Eudora soils, 6 to 12 percent slopes, eroded. Because the Eudora soils have short slopes, terraces are not suitable. In some fields it is necessary to construct diversion terraces to protect the soils in this unit from runoff water from higher areas. Returning all crop residue to the soil is a good way to improve tilth and also to protect this soil against erosion. Either bromegrass or native prairie grasses are suitable crops for waterways. All cultivated crops respond well to proper use of fertilizer. Lime is needed in some fields of legumes.

CAPABILITY UNIT IIIe-2

Ladysmith silty clay loam, 1 to 3 percent slopes, is the only soil in this capability unit. This soil occurs on uplands and is gently sloping and deep. Its subsoil is hard or firm, compact clay.

The soil in this unit has slow internal drainage. Because it absorbs water slowly, water erosion is a hazard. Because the tight clay subsoil fails to release water readily for plants, this soil is droughty in dry years.

Small grains, grain sorghum, soybeans, alfalfa, and tame and perennial grasses are suitable crops. Corn is sometimes damaged during dry periods.

Unless properly managed, this soil is subject to water erosion. Returning all crop residue to the soil and adding manure help to maintain the organic-matter content, to improve soil tilth, and to protect the soil against erosion. Terraces and contour farming are needed for controlling runoff. Growth of crops is increased by adding fertilizer and lime.

CAPABILITY UNIT IIIe-3

This unit consists of deep, well drained and moderately well drained loamy soils that have a clayey subsoil. These soils are in the Elmont, Labette, Martin, Pawnee, and Welda series. They are on sloping uplands and are slightly eroded.

The soils in this unit are easy to cultivate and fairly fertile. They have a high capacity for supplying water for growth of plants. Permeability is moderately slow to slow. The organic-matter content is moderate to high.

The main practices needed are those that maintain fertility and tilth and control erosion.

All cultivated crops commonly grown in the county are suited. Also suitable are grasses and trees. Wildlife habitat can be developed.

Practices that maintain organic matter and tilth are growing cover crops, applying manure, and returning crop residue. These practices also protect the soil against erosion. Terraces and contour farming are needed in cultivated fields for controlling runoff. Crops on these soils respond well to use of fertilizer and lime.

CAPABILITY UNIT IIIe-4

This unit consists of deep, sloping fine sandy loams on uplands. These soils have a sandy clay loam subsoil. They are in the Konawa and Shellabarger series.

These soils are very friable, but they are subject to both soil blowing and water erosion. Available moisture capacity is medium, and permeability is moderate. The main practices needed are those that help to control erosion and to maintain organic matter.

Wheat, grain sorghum, and alfalfa are well suited. Native grasses harvested for hay and used as pasture are also well suited. In most years corn is damaged during periods of dry weather.

Use of crop residue and additions of manure are helpful in maintaining organic matter and in protecting the soil against erosion. Terraces and contour farming are needed in cultivated fields. Maintaining grassed terrace outlets and waterways is difficult because gullies tend to form. Wheat and sorghums grow well if nitrogen and phosphate fertilizers are added in sufficient amounts.

CAPABILITY UNIT IIIe-5

This unit consists of deep, well drained to moderately well drained, sloping soils that have a clay subsoil. These soils are moderately eroded and occur on uplands. They are in the Elmont, Labette, Martin, and Pawnee series.

The original surface layer has been eroded so much that the soils are now less fertile and more difficult to farm than they were formerly. Since most of the topsoil is gone, every effort should be made to reduce soil losses. Practices are needed for controlling runoff and improving fertility and tilth.

Small grains, grain sorghum, alfalfa, sweetclover, and red clover are suitable cultivated crops. Corn and soybeans are generally not suitable. Tame and native grasses grow well on these soils, and trees are also suited. Wildlife habitat can be developed.

Crop residue, manure, and green-manure crops can be used to improve tilth and protect the soil against erosion. Terraces and contour farming also are needed in cultivated fields. In some areas diversion terraces are required. Tame or native grasses can be used for seeding waterways. All cultivated crops and tame grasses respond to additions of fertilizer and lime.

CAPABILITY UNIT IIIe-6

In this unit are deep, sloping, and moderately eroded soils that have a subsoil of clay loam or silty clay loam. These soils occur on uplands and are in the Gymer, Morrill, and Shelby series.

These soils are medium to low in fertility and organic-matter content. The chief management needs are practices that control runoff, prevent further erosion, and improve fertility and tilth.

All crops commonly grown in the county are suited to these soils, but sorghums are better suited than corn. Trees and tame and native grasses grow well. These soils can be developed as wildlife habitat and recreational sites.

To increase intake of water, improve tilth, and to reduce further loss of soil, all crop residue and manure should be used. In cultivated fields, terraces and contour farming are also required. All of the acreage of these soils has been cultivated, and reseeding grass would benefit some areas. Bromegrass and native prairie grasses are suitable for reseeding. All cultivated crops and tame grasses grow well if fertilizer and lime are properly added.

CAPABILITY UNIT IIIw-1

Wabash silty clay is the only soil in this capability unit. This soil is on bottom lands and is deep, nearly level, and somewhat poorly drained.

The soil in this unit is fertile, but it is difficult to work. It is sticky and plastic when wet and is hard when dry. It cracks deeply during dry periods, especially in fields of alfalfa. The very slow permeability restricts movement of air and water. Runoff is received from areas upslope, and this soil is sometimes flooded when streams overflow. Surface drainage is slow, and in some years crops are drowned.

If adequate drainage is provided, most crops commonly grown in the county are suitable, but vegetables, Irish potatoes, and nursery stock are not. Soybeans and grain sorghum are better suited than corn and wheat. Adequate drainage is essential if alfalfa is grown. This soil is suited to grasses and trees, and it can be developed as wildlife habitat.

Removing excess water and maintaining fertility are the main concerns in managing this soil. Proper use of crop residue and planting deep-rooted legumes are practices that help to maintain soil tilth. A bedding system for drainage helps to remove excess water. In some places it is necessary to construct diversion terraces so as to control water that runs in from adjacent slopes.

The soil of this unit is suitable for irrigation, but land leveling is commonly needed. Irrigations should be short and frequent because it is difficult for water to penetrate this soil below plow depth.

CAPABILITY UNIT IVe-1

Only Ladysmith silty clay loam, 1 to 3 percent slopes, eroded, is in this capability unit. This deep, gently sloping soil has a firm clay subsoil. It occurs on uplands and is moderately eroded.

Because this soil takes in water slowly, much water is lost in runoff. Erosion has thinned or removed the original surface layer, and the present plow layer contains little organic matter. Also, this soil is droughty and has poor tilth. The chief management needs are those practices that improve fertility and soil tilth. Also needed are practices that control runoff and erosion.

Wheat, alfalfa, sweetclover, and red clover are suitable cultivated crops. Grain sorghum is better suited than corn or soybeans. Native and tame grasses grow well.

In cultivated fields contour farming and terraces help to protect this soil against further erosion. By plowing under crop residue, barnyard manure, and green-manure crops, tilth is improved and runoff is lessened. Warm-season native grasses are suitable for seeding waterways. Additions of nitrogen, phosphate, and lime are needed on this soil. In some places potash is also needed.

CAPABILITY UNIT IVe-2

Sibleyville loam, 3 to 7 percent slopes, is the only soil in this capability unit. This moderately deep loamy soil occurs on uplands. It is friable and easy to cultivate but has medium to low fertility. Organic-matter content is fairly low. This soil is somewhat droughty, and it tends to erode easily.

Wheat, oats, grain sorghum, alfalfa, and sweetclover are suitable cultivated crops, but corn and soybeans are not suited. Native prairie and tame perennial grasses are well suited.

If this soil is cultivated, all crop residue and available manure should be turned under to help maintain or improve tilth and fertility. These practices also give some protection against erosion. In cultivated fields, terraces and contour farming are needed for controlling water erosion.

CAPABILITY UNIT IVe-3

This unit consists of deep, strongly sloping, well drained and moderately well drained loamy soils that have a silty clay loam or clay subsoil. These soils are on uplands and are only slightly eroded. They are in the Elmont, Martin, and Pawnee series.

These soils are fairly fertile. They have a high capacity for supplying moisture for growing plants. Permeability is moderately slow to slow. Because they are strongly sloping, the soils in this unit are subject to severe erosion. Where these soils are cultivated, maintaining soil tilth and fertility are also problems.

These soils are suited to the cultivated crops commonly grown in the county. They are also suited to tame and native grasses and to trees. Wildlife habitat can be developed.

Applying manure and returning all crop residue to the soil are practices that help to maintain fertility and tilth and to reduce erosion. In cultivated fields, terraces and contour farming help to control runoff. All tame grasses and cultivated crops respond well if commercial fertilizer and lime are added.

CAPABILITY UNIT IVe-4

This unit consists of deep, sloping, slightly eroded or moderately eroded loamy soils. These soils are in the Konawa and Shellabarger series. They have a sandy clay loam subsoil.

The soils of this unit have medium available moisture capacity. Their fertility and organic-matter content are medium to low. They are friable and erode easily. On these soils practices are needed for controlling runoff and maintaining fertility and tilth.

These soils are suited to wheat, grain sorghum, alfalfa, sweetclover, red clover, and tame grasses. In most years corn and soybeans are damaged during dry periods. Trees grow well, and wildlife habitat can be developed.

Native grasses provide the best cover for waterways. Applying all available manure and returning all crop residue to the soil help to maintain fertility and good tilth. These practices also protect the soil against blowing. In cultivated fields terraces and contour farming help to protect the soil against water erosion. Crops grown on these soils respond well if proper kinds and amounts of fertilizer are added. In some areas lime is needed for legumes.

CAPABILITY UNIT IVe-5

This unit consists of deep, well-drained loamy soils that have a clay loam subsoil. These soils are strongly sloping and occur on uplands. They are in the Morrill and Shelby series.

The soils of this unit are fairly fertile, and they store large amounts of moisture that can be readily released to growing plants. Permeability is moderately slow, and organic-matter content is moderate to high. Unless management provides protection, erosion is a severe hazard on these strongly sloping soils. Management is also needed for maintaining soil tilth and fertility.

These soils are suited to the crops commonly grown in the county. They are also suited to tame and native grasses and to trees. Wildlife habitat can be developed.

Fertility can be maintained or improved by applying all available manure and returning all crop residue to these soils. These practices also help to protect the soil from erosion. Terraces and contour farming help to control runoff. All cultivated crops and tame grasses respond well to additions of fertilizer and lime.

CAPABILITY UNIT IVe-6

This unit consists of deep, gently sloping, slightly acid to mildly alkaline soils on uplands. These soils are in the Dwight and Martin series. The Dwight soils have a thin surface soil underlain by a claypan subsoil. In the Martin soils the surface layer is thicker than that in the Dwight soils and the subsoil is silty clay.

The Dwight soils are droughty and difficult to work. They have low available moisture capacity, and they take in air and water very slowly. Martin soils are fertile and fairly easy to work. They have high available moisture capacity. On both kinds of soils practices are needed that maintain fertility and good tilth and that control runoff.

Only small areas of the soils in this unit are cropped. Most of the acreage is in native prairie grasses, which are better suited than row crops. Wheat, grain sorghum, and sweetclover are suitable crops. Alfalfa is suited to some areas, but corn and soybeans are not suited.

In cultivated fields returning all crop residue to the soil and maintaining good soil tilth are required for protection against erosion. Contour farming and stubble-mulch tillage are also needed to help control erosion. Seeding native grasses protects the waterways. Applicaitons of nitrogen and phosphate fertilizers are needed, but lime normally is not.

CAPABILITY UNIT IVs-1

Dwight silty clay loam, 0 to 1 percent slopes, is the only soil in this capability unit. This soil occurs on upland ridges and is deep and well drained to moderately well drained. It has a thin surface layer over a claypan.

The soil in this unit is low in content of organic matter. It is droughty and difficult to cultivate. Slickspots, or small depressions in which water sometimes stands, are common. Permeability is very slow.

Most of this soil is in grass, but a small part is cropland. Native grasses are better suited than cultivated crops. Wheat and sweetclover are suitable crops, but this soil is too droughty for corn or soybeans.

Maintaining fertility and good tilth is the main concern in managing this soil. If this soil is stubble mulched and crop residue is used properly, soil tilth is improved and the intake of water is increased.

CAPABILITY UNIT Vw-1

Only Kimo soils, depressional, are in this capability unit. These wet, deep, poorly drained soils are in areas of the valley of the Kansas River that are covered with shallow water most of the time.

These soils are fairly high in fertility, but they are generally so wet that cultivation is impractical. Internal and surface drainage are slow to very slow. Even though shallow water covers the surface some of the time, areas of these soils that occur as parts of cultivated fields are frequently cultivated during extended dry periods. Most fields, however, lie idle when they are too wet for cultivation. These soils are suited to trees and to wildlife habitat. Some tame and native grasses grow fairly well. Because it is not practical to provide drainage, cultivated crops are generally not suitable.

CAPABILITY UNIT VIe-1

The soils in this unit occur on uplands and are sloping to moderately steep and well drained to moderately well drained. They are in the Elmont, Martin, Morrill, Sibleyville, Vinland, and Shellabarger series. Also in the unit is Breaks-Alluvial land complex. The soils in this unit are generally moderately deep to deep. In most places a thin loamy surface layer is underlain by clayey material, but in other places the soil material is thin and gravelly. Rocks and stones crop out in a few small areas.

These soils have moderate to slow permeability and medium to high available moisture capacity. Fertility and the content of organic matter are fairly high. The hazard of erosion is severe.

These soils are well suited to perennial grasses and legumes that are used for hay and pasture. Trees also grow well, and wildlife habitat can be developed. Cultivated crops are not suited.

On these soils a protective cover is needed at all times so as to control erosion. Grazing on pasture and rangeland should be regulated. Also needed are practices for controlling brush and weeds. Tame grasses and legumes respond well to additions of fertilizer.

CAPABILITY UNIT VIe-2

The soils in this unit are very shallow to moderately deep, gently sloping to moderately steep, and loamy to clayey. They are in the Kipson, Sogn, and Vinland series.

Except for the rocky areas where the soil material is thin, these soils are naturally fertile. Available moisture capacity is generally moderate to high where the soils are moderately deep, but it is low in the very shallow Sogn soils. Runoff is medium to rapid.

These soils are well suited to native grasses and trees, and they can be developed as wildlife habitat. Most areas are in native grasses, some areas are wooded, and some small areas are cultivated. These soils, however, are not suitable for cultivation. They are well suited to native grasses. Regulation of grazing and control of weeds and brush are needed so as to maintain a cover of grasses that protects these soils against erosion.

CAPABILITY UNIT VIe-3

Martin soils and the Elmont-Slickspots complex are in this capability unit. The soils in this unit are sloping, deep, severely eroded, and loamy, and they are on uplands. These soils have a clayey subsoil.

These soils are now or have been cultivated. Because erosion is severe, organic-matter content and fertility are low. Soil tilth is poor, and runoff is rapid.

These soils are so severely eroded that they are no longer suitable for cultivation. A better use is native prairie grasses. Trees can be grown in some areas, and wildlife habitat can be developed.

Establishing and maintaining perennial grasses is a practical way to protect these soils against continued erosion. Constructing diversion terraces and land smoothing are practices needed to help establish perennial grasses. Additions of fertilizer encourage growth of a vigorous stand of tame grasses.

CAPABILITY UNIT VIs-1

Sarpy sand is the only soil in this capability unit. This nearly level to gently undulating soil occurs on the flood plain along the Kansas River.

This soil is very low in organic matter and fertility. Intake of water is rapid. Available moisture capacity is very low. The chief problems of management are soil blowing, low fertility, and droughtiness.

This soil occurs mostly in small areas surrounded by cultivated fields. It is managed as cropland, though it is not suitable for cultivated crops. Trees and native grasses are well suited. Some parts are in trees, mainly cottonwoods.

Practices are needed that maintain a year-round plant cover that protects the soil from blowing. The content of organic matter can be increased by turning under all crop residue.

CAPABILITY UNIT VIw-1

Only Alluvial land is in this capability unit. This land type is adjacent to small, intermittent streams and consists of deep loamy and clayey soil material. Areas of this land have been cut by meandering streams that generally are not deeply entrenched. Flooding is frequent.

Alluvial land stores large amounts of water and releases it readily to growing plants. Flooding, silting, and scouring are the main hazards.

Because flooding is frequent, this land is not suited to cultivated crops. Perennial grasses and trees grow well, however, and wildlife habitat and recreational areas can be developed.

Alluvial land supports a good stand of tame and native grasses. Tame grasses benefit if fertilizer is used properly. Wooded areas need protection from grazing. Wood crops can be increased by thinning stands, selective cutting, and preventing fires.

CAPABILITY UNIT VIIe-1

Only Stony steep land is in this capability unit. It consists of very shallow to moderately deep soil material that is steep and rocky.

This land is excessively drained and has rapid runoff. Although soil material is fertile, available moisture capacity is limited by the underlying limestone and shale.

Most of this land is in native prairie grasses, which is a good use. Some areas are in trees, but trees are not well suited. The wood products are mostly firewood. This land can be developed as wildlife habitat.

Careful management of grazing is needed to protect the vegetative cover. Renovating pasture or range is not practical, because this land is steep and stony. Protection from fire helps to maintain good stands of grass or trees.

CAPABILITY UNIT VIIw-1

Only Broken alluvial land is in this capability unit. It consists of deep loamy soil materials on the banks and in the channels of perennial streams. These soil materials are naturally fertile and have a good supply of available moisture. The main hazard is streambank cutting.

Because this land is subject to frequent overflow, only trees can be grown. Maintaining trees in adequate stands is a good way to protect this land against streambank cutting. Selective cutting, thinning, and protection from fire and grazing help to increase the amount of wood products.

CAPABILITY UNIT VIIIs-1

Only Riverwash is in this capability unit. It consists of deep sandy soil material along the Kansas River. Floodwaters shift this soil material so frequently that it has practically no value for farming. Some areas support stands of willows or cottonwoods and are useful as wildlife habitat.

Predicted Yields

Table 2 gives the predicted average yields per acre of the principal crops grown on the soils of the county. The yields, which are for nonirrigated soils, are estimated averages for corn, grain sorghum, soybeans, wheat, and alfalfa.

Soils not generally used for these crops are not listed in table 2. The yields are based on information obtained through interviews with farmers and agricultural workers and on information from records of yields on test plots managed by the experiment station at Kansas State University.

Yields in columns A are those expected under the average management, or the kind of management practiced by most farmers in the county. In this management—

1. Crop varieties used are suited to the area.
2. Proper seeding rates are used, and methods of planting and harvesting are suitable and timely.
3. Some practices for controlling weeds, diseases, and insects are used.
4. Starter fertilizers are applied.
5. Use of crop residue is limited.

Yields to be expected under improved management are listed in columns B. This management includes the following:

1. Crop varieties used are suited to the area.
2. Proper seeding rates are used, and methods of planting and harvesting are suitable and timely.
3. Optimum use of fertilizer and lime.
4. Use of terraces, contour farming, and grassed waterways.
5. Maximum use of crop residue for controlling soil blowing and water erosion, increasing intake of water, and encouraging emergence of seedlings.
6. Use of cropping systems that produce desired yields and keep the soil in good tilth.
7. Timely tillage.
8. Full and timely use of practices for controlling weeds, diseases, and insects.

Range Management[4]

Native grass grows on about 98,000 acres, or approximately 29 percent, of Shawnee County. Most of the rangeland lies in the western one-third of the county, though small tracts throughout the county are intermingled with larger areas in cropland. These small tracts generally are not suitable for cultivation.

About equally important in the livestock enterprise in the county are the raising of beef cattle and the purchase, feeding, and sale of stocker and feeder cattle. The success of these operations partly depends on the way ranchers and farmers manage their range. On almost all ranches some of the cropland is used for supplemental grazing. This grazing is mainly on pastures of wheat, rye, sudangrass, and bromegrass and on the stubble of corn and milo. In addition to the cropland pasture, about 36,000 acres of tame perennial pasture is used for grazing.

Tall and mid grasses cover most of the rangeland in the county. The dominant grasses are big and little bluestems, mixed with lesser amounts of switchgrass and indiangrass. Side-oats grama is a common increaser, except in areas of slickspots and of Dwight and Ladysmith soils, which have a clayey subsoil. In managing range in the western part of the county, brush is not a great concern. Where the range is overgrazed, however, buckbrush, smooth sumac, Osage-orange, honeylocust, and Virginia redcedar may limit the growth of desirable grasses. In the eastern part of the county, brush is a concern in some lowland and terrace areas. A continuous problem on the savannahs in the eastern part of the county are post oak, blackjack oak, blackbrush, smooth sumac, and wild rose.

[4] H. RAY BROWN, range conservationist, Soil Conservation Service, prepared this subsection.

TABLE 2.—*Predicted average yields per acre for principal nonirrigated crops grown under two levels of management*

[Absence of yield indicates that the soil is not suited to the crop]

Soil name	Corn		Grain sorghum		Soybeans		Wheat		Alfalfa	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Dwight silty clay loam, 0 to 1 percent slopes	------	------	15	25	------	------	15	25	------	------
Dwight silty clay loam, 1 to 3 percent slopes	------	------	14	24	------	------	14	24	------	------
Dwight-Martin silty clay loams, 1 to 3 percent slopes	25	40	35	50	14	21	20	30	1.5	2.5
Elmont silt loam, 3 to 7 percent slopes	38	60	45	70	20	30	25	40	2.4	3.5
Elmont silt loam, 3 to 7 percent slopes, eroded	30	50	40	60	17	28	20	37	1.5	2.5
Elmont silt loam, 7 to 12 percent slopes	25	45	30	50	20	27	15	28	2.0	2.8
Eudora sandy loam, sandy variant, 1 to 3 percent slopes	45	60	50	70	20	28	25	35	2.0	2.8
Eudora silt loam	70	96	75	100	38	45	35	55	3.6	4.6
Eudora soils, 6 to 12 percent slopes, eroded	40	60	50	65	20	30	23	30	3.0	4.0
Eudora-Kimo complex	65	85	70	90	32	41	33	50	3.3	4.0
Eudora-Kimo complex, overwash	60	76	68	85	28	38	30	46	2.8	3.8
Gymer silt loam, 3 to 8 percent slopes	50	70	65	80	28	36	30	45	3.0	4.0
Gymer silt loam, 3 to 8 percent slopes, eroded	28	55	38	62	20	28	22	32	1.8	3.0
Kennebec silt loam	49	70	53	83	25	38	23	36	3.0	4.0
Kennebec silt loam, clayey substratum	50	75	55	85	25	38	23	36	3.0	4.0
Kimo silty clay loam	55	70	65	80	27	38	30	45	2.8	3.8
Konawa fine sandy loam, 4 to 8 percent slopes	40	60	50	70	12	20	18	28	1.4	2.2
Konawa fine sandy loam, 8 to 12 percent slopes	30	46	40	55	9	14	15	25	1.2	1.9
Labette silty clay loam, 1 to 3 percent slopes	45	70	50	75	18	30	27	40	2.2	3.5
Labette silty clay loam, 3 to 6 percent slopes	40	67	45	70	15	27	25	38	2.0	3.2
Labette silty clay loam, 3 to 6 percent slopes, eroded	33	60	40	65	11	22	20	35	1.7	2.8
Ladysmith silty clay loam, 0 to 1 percent slopes	22	35	33	50	12	22	20	33	1.5	2.0
Ladysmith silty clay loam, 1 to 3 percent slopes	25	35	40	55	12	20	20	35	1.5	2.3
Ladysmith silty clay loam, 1 to 3 percent slopes, eroded	15	27	28	40	8	14	14	22	.8	1.3
Martin silty clay loam, 1 to 3 percent slopes	40	65	55	75	23	31	25	40	2.5	3.6
Martin silty clay loam, 3 to 7 percent slopes	36	58	50	74	21	28	23	37	2.5	3.6
Martin silty clay loam, 3 to 7 percent slopes, eroded	28	44	35	60	15	22	20	30	1.9	3.0
Martin silty clay loam, 7 to 11 percent slopes	35	48	45	65	20	27	22	34	2.1	3.0
Morrill clay laom, 3 to 8 percent slopes	38	60	44	70	20	28	22	33	2.0	3.3
Morrill clay loam, 3 to 8 percent slopes, eroded	28	44	33	53	15	23	13	22	1.1	2.2
Morrill clay loam, 8 to 12 percent slopes	30	48	35	60	18	25	15	27	1.6	2.8
Muir silt loam	60	95	70	100	38	45	35	48	3.8	5.0
Pawnee clay loam, 0 to 3 percent slopes	39	51	48	65	21	27	26	33	2.3	3.2
Pawnee clay loam, 3 to 7 percent slopes	45	63	55	75	20	30	25	36	3.0	4.0
Pawnee clay loam, 3 to 7 percent slopes, eroded	30	46	40	60	18	25	20	30	1.8	3.0
Pawnee clay loam, 7 to 11 percent slopes	32	48	40	60	17	23	20	30	2.0	3.0
Reading silty clay loam, 0 to 2 percent slopes	70	93	75	95	35	44	35	55	3.3	4.3
Sarpy-Eudora complex, overwash	50	75	60	75	20	28	27	40	2.5	3.2
Sharpsburg silty clay loam, 1 to 3 percent slopes	60	80	65	85	30	38	28	38	3.5	4.5
Sharpsburg silty clay loam, 3 to 6 percent slopes	50	70	62	83	28	35	26	36	3.3	4.3
Shelby clay loam, 1 to 3 percent slopes	50	70	60	80	27	31	24	35	3.6	4.6
Shelby clay loam, 3 to 8 percent slopes	45	65	55	75	24	32	22	32	3.4	4.4
Shelby clay loam, 3 to 8 percent slopes, eroded	22	40	25	50	18	25	14	30	2.5	4.0
Shelby clay loam, 8 to 12 percent slopes	32	48	40	57	17	25	19	27	1.7	2.6
Shellabarger fine sandy loam, 3 to 8 percent slopes	38	52	50	62	14	22	22	34	1.5	2.3
Shellabarger fine sandy loam, 3 to 8 percent slopes, eroded	28	40	45	60	9	17	16	27	1.2	2.0
Sibleyville loam, 3 to 7 percent slopes	27	48	32	50	13	20	18	28	1.9	2.9
Wabash silty clay	26	40	45	65	24	32	20	30	2.8	4.1
Wabash silty clay loam	55	75	60	85	30	38	28	39	3.6	4.8
Welda silt loam, 4 to 10 percent slopes	36	53	42	62	14	24	20	30	1.8	2.6

Range sites and condition classes

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. The soils that produce about the same kinds and amounts of forage when the ranges are in similar condition make up a range site. Range sites are areas of rangeland significantly different in the kinds or amounts of climax vegetation they produce. A significant difference is one great enough to require some change in management, such as a different rate of stocking. Different range sites are not recognized because of differences in soil or in climate, unless these factors result in a significant difference in the potential plant community.

Plants growing on a range site are called *decreasers*, *increasers*, and *invaders*. Decreasers are species in the potential plant community that tend to decrease under close grazing. They generally are the tallest and thickest perennial grasses and forbs and the most palatable to livestock. Because grazing animals seek out the most palatable plants, decreasers are first to disappear from overgrazed range. Increasers are species in the potential plant community that withstand grazing and increase in

relative amount as the more desirable plants are reduced by close grazing. These grasses and forbs are commonly shorter than decreasers, and some are less palatable to livestock. Invaders are plants that come in after the climax vegetation has been reduced by grazing. Many invaders are annual weeds; some are forbs that have some value for grazing, but others have little.

Range condition is classified according to the percentage of present vegetation on a range site compared to that of the climax vegetation, or the potential plant community for the range site. Classifying range condition provides an approximate measure of the deterioration that has taken place in the plant cover and thus provides a basis for predicting how much the range site can be improved. Four condition classes are defined. Condition is *excellent* if 76 to 100 percent vegetation is the same as that in the original stand; *good* if the percentage is 51 to 75; *fair* if the percentage is 26 and 50; and *poor* if the percentage is 25 or less.

Range condition is judged by comparing existing kinds and amounts of vegetation with kinds and amounts that would exist in the potential plant community. Keeping the range in excellent or good condition is one of the main objectives of good range management. Then water is conserved, plant growth is increased, and the soils are protected. Recognizing when changes take place in the kind of cover is important, but changes are gradual and can be miscalculated or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition when actually the cover is weedy and the trend is toward less forage growth. On the other hand, carefully managed rangeland that has been closely grazed for short periods may have a degraded appearance that temporarily conceals its quality and its ability to recover.

Descriptions of range sites

Described in the following pages are the range sites in the county, or groups of soils that have similar potential for producing range plants. The predicted yield of total air-dry herbage is given for each range site when it is in excellent condition. Also given are the principal decreasers, increasers, and invaders. To determine the soils that make up each range site, refer to the "Guide to Mapping Units" at the back of this survey.

BREAKS RANGE SITE

This range site consists of one mapping unit, Stony steep land. The soil material is shallow and moderately deep silt loam to silty clay loam. Rocks crop out in some places. Available moisture capacity is good. The site is excessively drained, and runoff is rapid.

On this site the potential plant community is chiefly little bluestem, side-oats grama, and other mid grasses. About 90 percent of the plant cover is made up of decreasers, such as little bluestem, big bluestem, switchgrass, indiangrass, prairie-clover, leadplant, and scurfpea. The principal increasers are side-oats grama, hairy grama, aromatic sumac, and smooth sumac. Broomweed is a common invader.

Generally, this site is in excellent condition. Because the land is rugged and stony, it is not readily accessible to livestock for grazing.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 4,500 pounds per acre.

CLAY LOWLAND RANGE SITE

On this range site are deep, poorly drained, slightly depressional to nearly level soils in alluvium. These soils have a clay to silty clay surface layer and subsoil. They receive extra moisture from floods or as runoff from adjacent areas. In some places shallow water covers the surface.

On this site the potential plant community is mostly tall grasses. About 95 percent of the plant cover is made up of decreasers, such as prairie cordgrass, eastern gamagrass, switchgrass, wildrye, big bluestem, and indiangrass. Nearly pure stands of prairie cordgrass are common in many areas. Among the principal increasers are western wheatgrass, tall dropseed, indigobush, amorpha, and sedges. Kentucky bluegrass, wild lettuce, and barnyard grass are common invaders.

Continuous overgrazing results in an immediate decrease in prairie cordgrass and eastern gamagrass. Western wheatgrass, bluegrass, and sedges carry the grazing load. This site is generally in fair condition.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 7,000 pounds per acre.

CLAY UPLAND RANGE SITE

This range site consists of deep, nearly level to sloping soils on uplands. The surface layer is silty clay loam 7 to 14 inches thick, and the subsoil is hard or firm clay and silty clay. These soils are slowly permeable to water and plants, but they have a high capacity to hold both water and nutrients.

The potential plant cover is mainly tall and mid grasses. About 75 percent of the plant cover is made up of decreasers, such as switchgrass, big bluestem, little bluestem, and indiangrass. Among the principal increasers are side-oats grama, tall dropseed, heath aster, and western ragweed. Common invaders are annual bromes, annual three-awns, and broomweed. If grazing is heavy, this site is likely to revert to droughty short grasses rather than to tall weeds and brush.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 5,000 pounds per acre.

CLAYPAN RANGE SITE

This range site is made up of deep, nearly level to gently sloping soils on uplands. These soils have a surface layer of silt loam to silty clay loam 3 to 8 inches thick and a subsoil of very firm, blocky clay. The soils are droughty because the clayey subsoil restricts the movement of moisture through the soil and the amount available to plants.

Decreasers make up about 70 percent of the total cover. Important decreasers are side-oats grama, switchgrass, little bluestem, big bluestem, tall dropseed, and slimflower scurf-pea. The main increasers are western wheatgrass, blue grama, buffalograss, and western ragweed. Windmillgrass, tumblegrass, and annual three-awns are common invaders.

Where overgrazing is continuous, buffalograss or western wheatgrass grow in nearly pure stands. Generally, this site is in poor to fair condition. Because the soils are nearly level to gently sloping, this site is readily accessible to livestock.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 3,000 pounds per acre.

LIMY UPLAND RANGE SITE

This range site consists of sloping to strongly sloping soils on uplands. The surface layer and subsoil are calcareous silty clay loam that overlies light-gray, soft, platy, calcareous shale. These soils are somewhat excessively drained. Runoff is medium to rapid. Permeability is moderate, but internal drainage is restricted because these soils are shallow to shale.

On this site the potential plant community is made up of tall and mid grasses. Big bluestem, little bluestem, indiangrass, switchgrass, prairie cordgrass, and similar decreasers make up about 85 percent of the total cover. Leadplant, prairie-clover, compassplant, catclaw sensitivebriar, Maximilian sunflower, and other decreaser forbs grow in large amounts. The main increasers are hairy grama and side-oats grama. Windmillgrass, tumblegrass, and broomweed are common invaders.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 5,000 pounds per acre.

LOAMY LOWLAND RANGE SITE

This range site consists of deep, well-drained, nearly level soils in alluvium. These soils have a loam to silty clay loam surface layer and subsoil, and they are moderately permeable to roots of plants and water. Capacity for holding both water and plant nutrients is high. Extra moisture is received in floods of streams or as runoff from adjacent areas.

In the potential plant community big bluestem is dominant, but there are also other decreasers, such as indiangrass, switchgrass, Canada wildrye, prairie cordgrass, and eastern gamagrass. These decreasers make up about 90 percent of the climax vegetation. Tall dropseed is the main increaser. Annual bromes, Kentucky bluegrass, and various kinds of woody plants are the common invaders.

Generally, this site is in fair condition. Western wheatgrass and bluegrass carry the grazing load.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 6,500 pounds per acre.

LOAMY UPLAND RANGE SITE

This range site is made up of well-drained, nearly level to steep soils on uplands. The surface layer is silty clay loam, and the subsoil is clay loam to clay or silty clay. These soils have high available moisture capacity and moderate permeability.

On this site the potential plant community is made up of mid and tall grasses (fig. 13). About 80 percent of the plant cover is made up of decreasers, such as big bluestem, indiangrass, switchgrass, leadplant, prairie-clover, and Jersey-tea ceanothus. The dominant increasers are side-oats grama, tall dropseed, ironweed, and woolly verbena. Windmillgrass, tumblegrass, broomweed, and woody plants are common invaders.

Under continuous overgrazing the amount of big bluestem and indiangrass is reduced and is followed by a decline in little bluestem. Side-oats grama increases rapidly on this site. Generally, the range site is in fair to good condition. The site is readily accessible to livestock, which have overgrazed it for a long period.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 5,000 pounds per acre.

SANDY RANGE SITE

In this range site are well-drained, strongly sloping or rolling soils on uplands. The surface layer is fine sandy loam. Available moisture capacity is medium, but a large part of the water stored is available for use of plants.

On this site the potential plant community is mid and tall grasses. About 80 percent of the plant cover is made up of decreasers, such as switchgrass, little bluestem, big bluestem, and indiangrass. Dominant increasers are sand dropseed, blue grama, and side-oats grama. Windmillgrass, tumblegrass, and sandbur are common invaders.

Continuous overgrazing results in an immediate decrease in big bluestem and indiangrass, followed by a decline in switchgrass. Sand dropseed increases rapidly on this site. Generally, the site is in poor to fair condition because it has been overgrazed for a long time, and it is readily accessible to livestock.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 5,000 pounds per acre.

SANDY LOWLAND RANGE SITE

This range site consists of well-drained to somewhat excessively drained soils. These soils are nearly level and occur on the flood plains of the Kansas River. The surface layer is fine sandy loam or silt loam. It is underlain by loam, loamy fine sand, or deep sand. These soils are moderately permeable to water and plant roots, but the capacity for holding both water and nutrients is low.

The potential plant community is a mixture of tall and mid grasses. Such decreasers as big bluestem, switchgrass, indiangrass, little bluestem, and Canada wildrye make up about 80 percent of the cover. Other perennial grasses and forbs account for most of the rest. Purpletop, side-oats grama, tall dropseed, and fall witchgrass are the principal increasers. Common invaders include windmillgrass, sandbur, and other annuals.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 6,000 pounds per acre.

SAVANNAH RANGE SITE

This range site consists of deep, well-drained soils that are sloping to strongly sloping and medium acid to strongly acid. Their surface layer is silt loam or fine sandy loam. The subsoil is silty clay or sandy clay loam. Runoff is medium to rapid, and permeability is moderately slow.

The potential plant community is a mixture of mainly tall grasses. About 50 percent of the total cover is made

Figure 13.—**Native grasses in excellent condition on Loamy Upland Range site.**

up of such decreasers as big bluestem, little bluestem, switchgrass, indiangrass, and Canada wildrye. The main increasers are side-oats grama, hairy dropseed, tall dropseed, and purpletop. Normally, this range site has a canopy that covers about 25 percent of the site and consists of post oak, blackjack oak, and species of woody shrubs. Common invaders are splitbeard bluestem, silver bluestem, and annuals.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 4,000 pounds per acre.

SHALLOW RANGE SITE

This range site consists of gently sloping to steep, granular silty clay loams. These soils are very shallow to limestone. Slopes range from 3 to 25 percent. The site is excessively drained; runoff is rapid; and internal drainage and penetration of roots are restricted.

Little bluestem, side-oats grama, and other mid grasses are dominant in the potential plant community. About 90 percent of the cover consists of decreasers, such as little bluestem, big bluestem, switchgrass, indiangrass, prairie-clover, leadplant, scurf-pea, willowleaf sunflower, and blacksamson. The main increasers are side-oats grama, aromatic sumac, and smooth sumac. Invaders include annual three-awns, broomweed, and leavenworth eryngo.

Where this range site is in excellent condition and rainfall is average, the average annual yield of air-dry herbage is about 3,000 pounds per acre.

Woodland Management [5]

Discussed in the subsection are soils that have been placed in eight woodland suitability groups on the basis of their suitability as woodland. Also discussed are broad groups of soils that have been placed in four windbreak suitability groups according to their suitability for trees planted in windbreaks. Some limitations that affect management are also discussed.

Native woodland

Native trees grow on about 21,000 acres in Shawnee County. This woodland generally occurs as narrow bands

[5] Prepared with the help of F. D. ABBOTT, Soil Conservation Service.

and patches of trees along the creeks and rivers and on some of the steeply sloping parts that border the stream valleys. Many of the stands would produce sawtimber if well managed, but most have been managed poorly. All the native woodland needs to be protected from fire and grazing and cleared of cull trees and wolf trees. A wolf tree is a tree that occupies more space than its value warrants, thus curtailing the space available to better species.

Management of woodland suitability groups

In this subsection the woodland suitability groups for Shawnee County are described. The soils in each group are suited to trees that produce similar kinds of wood crops. They require about the same kind of management and have about the same potential productivity.

In each woodland suitability group, the soils can be identified by referring to the "Guide to Mapping Units" at the lack of this survey. More detailed information about the soils is given in the section "Descriptions of the Soils." Some of the terms used in the descriptions of the woodland suitability groups need an explanation.

Potential productivity for wood crops is expressed as *site index*, which is the average height, in feet, of the dominant and codominant species at the age of 50 years.

Seedling mortality refers to the expected degree of mortality of naturally occurring or planted seedlings as influenced by soil texture, depth, drainage, flooding, height of the water table, and degree of erosion. Normal rainfall, good planting stock, and proper planting are assumed. Mortality is *slight* if the expected loss is less than 25 percent; *moderate*, 25 to 50 percent; or *severe*, more than 50 percent.

Plant competition refers to the invasion or growth of unwanted trees, shrubs, vines, or other plants when openings are made in the canopy. Competition is *slight* if competing plants do not hinder the establishment of a desirable stand; *moderate* if they delay the establishment of a desirable stand; and *severe* if they prevent the establishment of a desirable stand unless intensive cultural measures are applied.

The ratings for equipment limitations are based on the degree that soils and topographic features restrict or prohibit the use of equipment normally employed in tending a crop of trees. The limitation is *slight* if there is little or no restriction on the type of equipment that can be used, or the time of year that equipment can be used. It is *moderate* if the use of equipment is seasonally limited, or if modified equipment or methods of harvesting are needed. The limitation is *severe* if special equipment is needed or if the use of such equipment is severely restricted by one or more unfavorable soil characteristics.

Erosion hazard is rated according to the risk of erosion on woodland where normal practices are used in managing and harvesting trees. It is *slight* if erosion control is not an important concern. The hazard is *moderate* if some attention must be given to check soil losses. It is *severe* if special treatment or special methods of operation are necessary.

Windthrow hazard depends on development of roots and the capacity of soil to hold trees firmly. The hazard is *slight* if windthrow is no special concern; *moderate* if roots hold the trees firmly, except when the soil is excessively wet or when the wind is strongest. The hazard is *severe* if many trees may be blown over because their roots cannot provide enough stability.

WOODLAND SUITABILITY GROUP 1

This woodland group consists of well drained to moderately well drained, deep, nearly level soils in alluvium. These soils are on bottom lands along all streams in the county. Internal drainage is medium to slow. Permeability is moderate to slow. Generally, the soils in this group occupy high bottom lands that are seldom flooded or low areas along streams that frequently are flooded for short periods.

Soils in this group are well suited to trees. For the mixed hardwoods, the site index ranges from about 70 to 83.

Frequent floods in spring and droughts in summer result in moderate seedling mortality. Plant competition is severe. Because vines and weed trees slow growth of desirable species, this competition needs to be reduced.

Equipment limitations are slight. Only flooding prevents logging and other equipment from operating. Windthrow hazard is slight, and special practices are not needed to prevent windthrow. Any method of thinning or harvesting may be used.

The erosion hazard is slight. Clear cutting near or in old, or existing, stream channels should be avoided so as to keep banks from eroding.

The soils in this group are suited to cottonwood, black walnut, bur oak, soft maple, green ash, hackberry, and hickory.

WOODLAND SUITABILITY GROUP 2

This woodland group consists of deep, nearly level, somewhat poorly drained soils on bottom lands. These soils are commonly wet and in most places are subject to occasional flooding.

Soils in this group are well suited to trees. For the mixed hardwoods, the site index ranges from about 60 to 75.

Seedling mortality is moderate because water stands on the surface and flooding occurs in spring. Plant competition is severe, and desirable species do not grow well unless competition from weed trees and vines is reduced.

Equipment limitations are severe. Except during the driest months, equipment compacts these soils and roots may be damaged. Also severe is the windthrow hazard. To prevent windthrow stands should be opened slowly and single trees should not be left in a stand.

The erosion hazard is slight. Alluvium commonly is deposited along streams, but only the large floods damage these soils.

The soils of this group are suited to soft maple, bur oak, hackberry, green ash, hickory, and cottonwood.

WOODLAND SUITABILITY GROUP 3

This woodland group consists of deep, gently sloping to strongly sloping, silty and loamy soils on uplands. These soils are well drained and moderately permeable to moderately slowly permeable.

The soils in this group are moderately suited to trees. For the mixed hardwoods in the existing stands, the site index ranges from about 50 to 60.

For preferred species, seedling mortality is moderate because of droughts in summer, especially during prolonged dry weather. Plant competition is slight, and special treatment is not needed for natural regeneration and growth of trees.

Equipment limitations are moderate. Use of logging equipment needs to be restricted during the wettest months and in shorter rainy periods so as to prevent the soils from compacting and to prevent damage to roots of trees. Because the windthrow hazard is moderate, caution should be used in opening dense stands.

The erosion hazard is moderate. Most erosion is controlled if good practices are used in constructing roads and trails.

These soils are suited to red oak, black oak, black walnut, hickory, and green ash.

WOODLAND SUITABILITY GROUP 4

This woodland group consists of deep, well drained and moderately well drained, clayey soils. The soils in this group are gently sloping to strongly sloping and occur on uplands.

These soils are moderately well suited to trees. The site index for suitable mixed hardwoods ranges from about 55 to 70.

Seedling mortality is slight, and soil characteristics do not limit survival of seedlings and growth of trees. Plant competition is moderate, though practices are needed for controlling weed trees and insuring adequate growth and full stocking.

Equipment limitations are moderate. Use of logging equipment needs to be restricted in the wettest months and in shorter rainy periods so as to prevent soil compaction and damage to roots. Because the windthrow hazard is slight, any method of thinning and harvesting trees is suitable.

The erosion hazard is moderate to severe. Sheet and gully erosion is prevented by using caution when removing trees.

These soils are suited to black walnut, red oak, black oak, hackberry, green ash, and hickory.

WOODLAND SUITABILITY GROUP 5

This woodland group consists of deep, sandy and loamy soils on bottom lands that are infrequently flooded. Permeability is moderately rapid to rapid, and there is little surface runoff. These soils are well suited to trees.

The site index for cottonwoods ranges from about 65 to 75 (fig. 14). Seedling mortality is slight because the soil characteristics are favorable for easy establishment and rapid growth of seedlings. Plant competition is slight, and special practices are not required for natural regeneration and growth of trees.

Equipment limitations are slight; only floods limit the use of equipment. Because the windthrow hazard is moderate, it is necessary to use caution when opening dense stands and to avoid leaving single seed trees standing.

The erosion hazard is slight. Only the major floods cause damage, though deposits of alluvium are common.

Cottonwood and sycamore are suitable species on these soils.

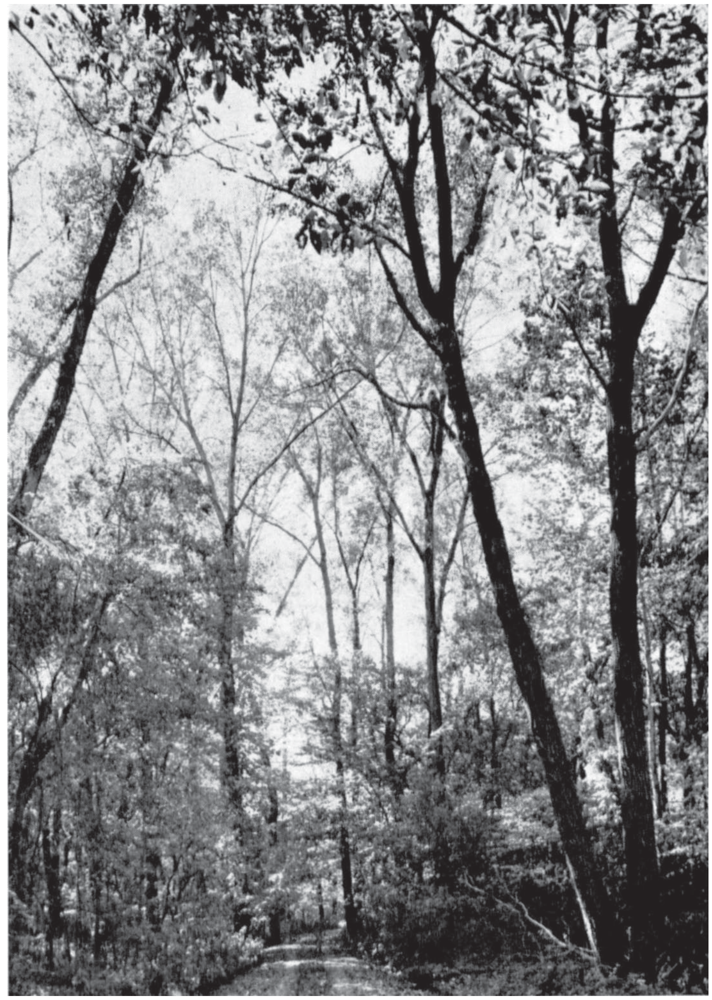

Figure 14.—**Woodland sites on Eudora and Sarpy soils produce cottonwoods that are excellent sawtimber. (Courtesy of *Kansas State Forester,* Kansas State University.)**

WOODLAND SUITABILITY GROUP 6

This woodland group consists of deep, well-drained, silty soils on the higher lying bottom lands. These soils are seldom flooded. Internal drainage is medium, permeability is moderate, and surface runoff is slow.

The soils in this woodland group are well suited to trees. The site index ranges from about 60 to 75 for suitable mixed hardwoods.

Seedling mortality is slight. Soil characteristics are favorable for survival and growth of seedlings. Plant competition is moderate, and some practices are needed for removing competing vines and weed trees.

Equipment limitations are slight. Use of equipment is limited only by occasional flooding. The windthrow hazard is slight, and any method of thinning or harvesting can be used.

The erosion hazard is slight. Erosion of streambanks is prevented if clear cutting near or in old, or existing, stream channels is avoided.

These soils are suited to black walnut, bur oak, green ash, hackberry, and cottonwood.

WOODLAND SUITABILITY GROUP 7

This woodland group consists of well-drained, sloping and strongly sloping soils on uplands. These soils are moderately deep over weathered sandstone and sandy and silty shale. Surface runoff and internal drainage are medium. Permeability is moderate.

The soils in this group are generally moderately suited to poorly suited to trees. The site index for the mixed hardwoods ranges from about 40 to 65.

Seedling mortality is moderate, and during droughts in summer some seedlings are lost. Plant competition is slight; special practices are not required for controlling competing plants.

Equipment limitations are slight. Only the most severe wet weather limits the use of equipment. Because the windthrow hazard is slight, any method of thinning or harvesting is suitable.

The erosion hazard is moderate to slight. Most erosion is controlled if good practices are used in constructing roads and trails.

These soils are suited to red oak, bur oak, hickory, and chinquapin oak.

WOODLAND SUITABILITY GROUP 8

This woodland group consists of deep, sloping to strongly sloping, loamy soils on uplands. The soils in this unit are well drained and have moderate permeability.

These soils are suitable for trees. The site index ranges from 60 to 70 for suitable mixed hardwoods.

Seedling mortality is moderate for preferred species because of droughts in summer, especially during prolonged dry periods. Plant competition is slight, and special treatment is not needed for natural regeneration and growth of trees.

Equipment limitations are slight. Only severe wet weather limits the use of equipment. Because the windthrow hazard is moderate, caution should be used in opening dense stands.

The erosion hazard is moderate. Most erosion is controlled if good practices are used in constructing roads and trails.

These soils are suited to black walnut, black oak, red oak, bur oak, hackberry, green ash, and hickory.

Farmstead windbreaks

Farmsteads exposed to cold winds in winter and hot winds in summer need the protection of windbreaks. Trees and shrubs for windbreaks should be selected according to their suitability for the soils, but for Shawnee County it is not necessary to place individual soils in groups similar to woodland suitability groups. For windbreak plantings, the soils in the county are placed in four broad groups as follows:

For moderately deep and deep silty soils, clay loams, and fine sandy loams, the following trees and shrubs are suitable: Eastern redcedar, Austrian pine, ponderosa pine, Chinese elm, hackberry, green ash, bur oak, mulberry, Russian-olive, honeylocust, wild plum, lilac, bush-honeysuckle, cotoneaster, multiflora rose, and western chokecherry.

For moderately deep and deep clayey soils and severely eroded silt loams and silty clay loams, the following are suitable: Eastern redcedar, Austrian pine, ponderosa pine, hackberry, Chinese elm, honeylocust, mulberry, wild plum, and roughleaf dogwood.

For shallow, rocky soils, and shallow to moderately deep clays and silts over shale, chert, and limestone, the following are suitable: Eastern redcedar, Chinese elm, honeylocust, ponderosa pine, wild plum, roughleaf dogwood, and skunkbush sumac.

For sandy soils, the following are suitable: Eastern redcedar, ponderosa pine, cottonwood, Chinese elm, green ash, hackberry, sand plum, Russian-olive, and mulberry.

More information on windbreak plantings can be obtained from a local technician of the Soil Conservation Service or from the county agricultural extension agent.

Wildlife Management [6]

The kinds and amounts of wildlife in Shawnee County and elsewhere are mainly determined by land use and by the fertility, topography, permeability, and depth of the soils. If land use is changed, the wildlife in the area also is likely to change.

The potential of each soil association in the county for producing food and cover for the various kinds of wildlife is rated in table 3. The section "General Soil Map" tells something about the soils in each association, and the section "Descriptions of the Soils" gives more information. The general soil map at the back of this survey shows the location of each association in the county.

In table 3 the wildlife in the county are classified as openland, woodland, and wetland.

Openland wildlife are animals that normally inhabit croplands, pastures, meadows, and odd fields of herbaceous vegetation. They include pheasant, quail, meadowlarks, cottontail, coyote, and badger.

Woodland wildlife include animals that normally inhabit wooded areas of trees and shrubs. They require more of the wooded type of cover mixed with other types. Whitetailed deer, squirrel, raccoon, and thrushes are kinds of woodland wildlife.

Wetland wildlife are animals that normally inhabit wet areas, such as ponds, marshes, rivers, streams, and swamps. They include ducks, shorebirds, beaver, mink, and muskrat.

The soils of Shawnee County provide suitable habitats for many kinds of animals and birds. The most important game bird is the bobwhite (quail). Average densities on the Reading-Wabash and Eudora-Muir associations may reach one bird for each 2 acres of soils. These soils in alluvium also produce suitable habitat for deer, racoon, fox and gray squirrels, mink, muskrat, beaver, opossum, and songbirds, such as thrushes and cardinals.

Pheasants are scarce throughout the county, though the northern half has been open to hunters for a limited season. In the western half of the county, prairie chickens are in small areas, primarily in the Martin-Ladysmith association and in some parts of the Pawnee-Shelby-Morrill and Martin-Sogn associations. The preferred habitat for prairie chickens consists of extensive areas of mixed native grasses interspersed with small fields of cultivated

[6] By JACK W. WALSTROM, biologist, Soil Conservation Service.

TABLE 3.—*Potential of the soil associations for providing habitats required for various kinds of wildlife*

Soil association	Kinds of wildlife	Potential for producing, for kinds of wildlife named—		
		Woody cover	Herbaceous cover	Food
Reading-Wabash.	Openland	Excellent	Excellent	Excellent.
	Woodland	Excellent	Excellent	Excellent.
	Wetland	Excellent	Excellent	Excellent.
Eudora-Muir.	Openland	Excellent	Excellent	Excellent.
	Woodland	Excellent	Excellent	Excellent.
	Wetland	Excellent	Excellent	Excellent.
Pawnee-Shelby-Morrill.	Openland	Good	Excellent	Excellent.
	Woodland	Fair	Excellent	Excellent.
Ladysmith-Pawnee.	Openland	Fair	Excellent	Excellent.
	Woodland	Poor	Excellent	Excellent.
Martin-Pawnee-Labette.	Openland	Good	Excellent	Excellent.
	Woodland	Fair	Excellent	Excellent.
Martin-Ladysmith.	Openland	Fair	Excellent	Excellent.
	Woodland	Fair	Excellent	Excellent.
Gymer-Shelby-Sharpsburg.	Openland	Excellent	Excellent	Excellent.
	Woodland	Excellent	Excellent	Excellent.
Martin-Sogn.	Openland	Good	Excellent	Excellent.
	Woodland	Good	Excellent	Excellent.

crops, generally in the ratio of two-thirds of grassland to one-third of cropland.

Within the Pawnee-Shelby-Morrill association, the Shawnee County State Lake provides good fishing for bass, bluegill, and channel catfish. The estimated fish production is 300 pounds per acre of water.

The soils on the alluvial plain along the Kansas River are good habitats for wetland wildlife. These soils are in the Reading-Wabash and Eudora-Muir associations. Good opportunities for fishing are also provided on the rivers and streams.

Lake Shawnee is adjacent to the southeast boundary of Topeka and is surrounded by the Martin-Pawnee-Labette association. It is well developed for recreation, and it produces large numbers of game fish. Picnicking, camping, fishing, and sightseeing are a few of the activities enjoyed.

The mourning dove, a popular game bird in Kansas, builds nests in habitat produced on all soil associations within the county. This dove depends heavily on seeds as a food source and, consequently, herbaceous habitat is vitally important for food. Doves largely depend on farm ponds and stock-water tanks for their water. Migrating waterfowl alight on the many farm ponds throughout the county.

Whitetailed deer are increasing in the county. During hunting seasons each fall hunters are allowed to shoot surplus animals. Deer habitat is available on all soil associations, but the best habitat is on soils in alluvium along the Kansas River and its major tributaries.

Cottontail rabbits frequent all soil associations in the county. If proper kinds of food and cover are interspersed, the carrying capacity for this species is increased. The most productive habitats are on the Reading-Wabash and Eudora-Muir associations. Heavy brushy thickets are required to shelter a large population of rabbits. Good habitats have one cottontail per acre.

Developing a specific habitat for wildlife requires that the plant cover is the kind that the soils can produce and that it is properly located. Onsite technical assistance in planning developments for wildlife and in determining suitable species of vegetation for planting can be obtained from the office of the Soil Conservation Service. Additional information and assistance can be obtained from the Bureau of Sports, Fisheries, and Wildlife; from the Kansas Forestry, Fish and Game Commission; and from the Extension Service.

Engineering Uses of Soils [7]

This subsection describes the systems of engineering soil classification currently used and gives engineering test data for selected soil types in Shawnee County. Engineering properties of the soils in the county are estimated, and soil features that affect the use of soil in engineering structures and practices are listed.

Soils are not homogeneous, and before engineers can evaluate the properties of a specific soil, they need a broad understanding of soils and also knowledge of their behavior that has been gained through observation. Engineers are interested in soil properties because many of these properties affect design, construction, and maintenance of structures. The soil properties most important to the engineer are permeability to water, shear strength,

[7] KEITH M. DONELSON, civil engineer, Soil Conservation Service, assisted in preparing this subsection.

compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and reaction. Depth to water table, depth to bedrock, and topography are also important.

The information in this survey can be used to—

1. Make studies of soil and land use that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in planning agricultural drainage systems, farm ponds, terraces, waterways, dikes, diversion terraces, irrigation canals, and irrigation systems.
3. Make preliminary evaluations of the soil and ground conditions that will aid in selecting locations for highways and airports and in planning detailed investigations at the selected location.
4. Locate probable sources of gravel, sand, and other construction materials.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soil units for supporting vehicles and construction equipment that move across them.
7. Supplement information obtained from other published maps and reports and from aerial photographs for the purpose of making maps and reports that will be more useful to engineers.
8. Make preliminary evaluation of the suitability of a particular area for construction purposes.

The engineering interpretations in this subsection can be useful for many purposes, but it should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Even in these situations, however, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms used by the soil scientists may not be familar to the engineer, and some terms may have a special meaning in soil science. Several of these terms are defined in the Glossary at the back of this survey.

Most of the information in this subsection is in tables 4, 5, and 6, but additional information useful to engineers can be found in other sections of this soil survey, particularly "Descriptions of the Soils," and "Use of Soils for Recreational Sites."

Engineering classification systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture (*9*). This system is useful only as the initial step for making engineering classifications of soils.

Two systems are used by engineers for classifying soils. These are the systems used by the American Association of State Highway Officials (AASHO) (*1*) and the Unified system developed by the Corps of Engineers, U.S. Army (*11*). These systems are explained briefly in the following paragraphs (*7*).

AASHO classification system.—The AASHO system is based on actual performance of material that is used as a base for roads and highways. In this system all the soil materials are classified in seven basic groups. The soils most suitable for road subgrade are classified A-1, and those least suitable are classified A-7. Within fairly broad limits, soils are classified between these two extremes according to their load-carrying ability.

Three of the seven basic groups may be further divided into subgroups to designate variations within a group. Within each group or subgroup, the relative engineering value of the soil material is indicated by a group index number, which is shown in parentheses following the group classification. Group indexes range from 0 for the best material to 20 for the poorest. Increasing values of group indexes denote decreasing load-carrying capacity. In this survey group indexes are given only for those soils for which laboratory data were available (see table 4).

In the AASHO system, the soil materials may be placed in the following general groups: (1) Granular materials in which 35 percent or less passes a No. 200 sieve; and (2) silt-clay materials in which more than 35 percent passes a No. 200 sieve. The silty part of the silt-clay materials has a plasticity index of 10 or less, and the clayey material has a plasticity index greater than 10. The plasticity index refers to the numerical difference between the liquid limit and the plastic limit. The liquid limit is the moisture content, expressed in percentage of the ovendry weight of the soil, at which the soil material passes from a plastic to a liquid state. The plastic limit is the moisture content, expressed in percent of the ovendry weight of the soil, at which the soil material passes from a semisolid to a plastic state.

Unified classification system.—In the Unified system the soils are grouped on the basis of their texture and plasticity, as well as on their performance when used in engineering structures. The soil materials are identified as coarse grained, gravel (G) and sand (S); fine grained, silt (M) and clay (C); and highly organic (Pt). No highly organic soils were mapped in Shawnee County.

Under the Unified system, clean sands are identified by the symbols SW or SP; sands with fines of silt and clay are identified by the symbols SM and SC; silt and clay that have a low liquid limit are identified by the symbols ML and CL; and silt and clay that have a high liquid limit are identified by the symbols MH and CH.

On the basis of visual field inspection, an engineer can make an approximate classification of soils in the field. Exact classification, however, must be based on the review and application of data from a complete laboratory analysis. Field classifications are useful for planning more detailed analysis at the site of construction.

Engineering test data

Engineering test data for four soil series are given in table 4. Samples were taken, by horizons, from nine soil profiles in Shawnee County and were tested by the State Highway Commission of Kansas in accordance with standard procedures of the American Association of State Highway Officials.

The engineering soil classifications in table 4 are based on data obtained by mechanical analyses and by tests to determine the liquid limit and the plastic limit.

Engineering properties of the soils

In table 5, by soil layers, are estimates of important properties that affect the use of soils in Shawnee County for engineering. The estimates are based on laboratory data given in table 4; on laboratory tests of similar soils in other counties; on tests made by the State Highway Commission; on field observations; and on information in other sections of the survey.

The following land types have variable properties and were not included in table 5: Alluvial land, Breaks-Alluvial land complex, Broken alluvial land, Made land, Riverwash, and Stony steep land. Also, estimates are not given for the Slickspots part of Elmont-Slickspots complex, 3 to 7 percent slopes, eroded, and the Gravelly land part of Morrill-Gravelly land complex, 4 to 12 percent slopes. Some of the columns require explanation.

The depth from the surface and the estimates of properties are generally those for the layers in the profile described as typical for the series in the section "Descriptions of the Soils." For some series, however, estimates were made for layers in more than one profile. The soil material is classified according to textural terms of the United States Department of Agriculture and according to the AASHO and Unified systems. Also listed for the layers are the estimated percentages of material that passes No. 4, No. 10, and No. 200 sieves.

Permeability is the quality of the soil that enables it to transmit water and air. In table 5 permeability is given, in inches of water percolation per hour, in undisturbed soil material.

Available water capacity, estimated in inches per inch of soil depth, is the amount of moisture that the soil can hold in a form that is readily available to plants. It is the difference between the amount of moisture in a soil at field capacity and the amount in the soil at the permanent wilting point.

The acid or alkaline reaction of the soil is expressed as a range in pH values. A pH of 7.0 is neutral; values lower than 7.0 are acid, and values higher are alkaline. Salinity is not a problem in Shawnee County.

Shrink-swell potential indicates how much the volume of the soil layers changes as a result of changes in their moisture content. Soils that contain a large amount of clay, such as the Wabash, have *high* shrink-swell potential. Those that contain a high percentage of sand and small amounts of nonplastic fine material have *low* shrink-swell potential. A knowledge of this potential is valuable in planning the use of a soil in the building of roads or other structures.

During a part of most years the Kimo soils, depressional, are covered by shallow water. Alluvial land, Kimo silty clay loam, and the Eudora, Kennebec, Sarpy, and Wabash soils are subject to occasional flooding. In Kimo soils, depressional, the seasonal water table is 0 to 2 feet below the surface, and it is 1 to 3 feet below the surface in Kimo silty clay loam. In all other soils in Shawnee County, the water table is more than 5 feet below the surface.

Engineering interpretations of the soils

In table 6 the soils in the county are rated according to their suitability as sources of topsoil, sand or gravel, road fill, and subgrade material. Also given in table 6 are specific properties that affect the use of the soils in engineering structures and practices. Because they have such variable properties, the following land types were not listed in table 6: Alluvial land, Breaks-Alluvial land complex, Broken alluvial land, Made land, Riverwash, and Stony steep land. Also not listed in table 6 is the Slickspots part of Elmont-Slickspots complex, 3 to 7 percent slopes, eroded, and the Gravelly land part of the Morrill-Gravelly land complex, 4 to 12 percent slopes.

The suitability of the soils as a source of topsoil is shown in table 6 by a rating of *good*, *fair*, *poor*, or *not suitable*. Suitability of a soil used as topsoil is important because topsoil is needed for growing vegetation that controls erosion on embankments, on road shoulders and ditches, and on cut slopes. The ratings for topsoil are based on the content of organic matter in the soil, available moisture capacity, natural fertility, and tilth.

Also rated in table 6 is the suitability of the soils as a source of sand or gravel. In this county the sand from the various sources is mostly poorly graded and contains too much silty material to be suitable for use in concrete. If confined, however, the sand is a good source of fill material. The only sources of gravel occur as localized pockets in the soils formed from glacial material. The Gravelly land part of Morrill-Gravelly land complex, 4 to 12 percent slopes, is a fair source of gravel. The pockets of gravel in the Gravelly land contain variable amounts of sand, silt, clay, and boulders.

Suitability of the soil materials for road fill and road subgrade largely depends on the texture, load-carrying capacity, and the natural water content of the soil materials. Highly plastic soil materials are rated *poor* for road subgrade and *poor* or *fair* for road fill. Sandy soil material may be rated *good* for road subgrade. For road fill, however, sandy material is rated *fair* or *poor* because it is easily eroded and vegetation is difficult to establish and maintain on it.

In table 6 the soils are rated as having *slight*, *moderate*, or *severe* limitations for sewage disposal. *Slight* limitations indicate no really unfavorable features. The feature or features that cause a limitation of *moderate* or *severe* are listed. A feature that is not favorable to using a soil for septic tanks may be favorable to using the soil for lagoons. Among the soil features considered in estimating the limitations of soils for sewage disposal were soil permeability, ground water levels, flood hazard, slope, and depth to bedrock.

Soil features that affect the reservoir areas of farm ponds include permeability, seepage, and depth to bedrock. Among the features that affect embankments are stability of soil material, shear strength, shrink-swell potential, and erodibility.

Agricultural drainage is affected by permeability, ponding, and slopes. Also important is the availability of outlets.

Features that affect irrigation are water intake rate, permeability, water-holding capacity, depth to bedrock, and susceptibility to flooding.

TABLE 4.—*Engineering*

[Tests performed by the State Highway Commission of Kansas under a cooperative agreement with the Bureau of Public

Soil name and location	Parent material	SCS sample No.	Depth	Moisture-density[1] Maximum dry density	Moisture-density[1] Optimum moisture
			In.	*Lb. per cu. ft.*	*Percent*
Ladysmith silty clay loam:					
600 feet south and 50 feet east of the northwest corner of the NE¼ sec. 6, T. 12 S., R. 17 E. (Modal)	Heavy silty clay loam, probably of loessal origin.	S-62-Kans-			
		89-3-1	0-6	101	20
		89-3-2	8-25	93	23
		89-3-3	40-52	98	21
100 feet south of the northwest corner of the SW¼ sec. 7, T. 13 S., R. 16 E. (Modal)	Light silty clay, probably of loessal origin.	S-64-Kans-			
		89-34-1	0-10	93	25
		89-34-2	12-24	91	25
		89-34-3	32-48	99	21
		89-34-4	48-72	99	21
Labette silty clay loam:					
500 feet south and 1,125 feet west of the northeast corner sec. 1, T. 12 S., R. 16 E. (Nonmodal; depth to bedrock greater than modal)	Residuum from interbedded limestone and clay shale.	S-62-Kans-			
		89-4-1	0-10	98	19
		89-4-2	20-38	97	24
1,200 feet south of northwest corner of the SW¼ sec. 27, T. 12 S., R. 16 E. (Modal)	Residuum from interbedded limestone and clay shale.	S-64-Kans-			
		89-35-1	0-9	91	26
		89-35-2	13-22	93	24
		89-35-3	22-42	97	23
Martin silty clay loam:					
500 feet south and 440 feet west of the northeast corner sec. 5, T. 12 S., R. 17 E. (Modal)	Soft, weakly bedded clay shale.	S-62-Kans-			
		89-1-1	0-7	95	21
		89-1-2	16-30	97	21
		89-1-3	63-108	99	21
100 feet south and 720 feet west of the northeast corner of the NW¼ sec. 3, T. 12 S., R. 17 E. (Modal)	Soft, weakly bedded clay shale.	S-62-Kans-			
		89-2-1	0-7	95	21
		89-2-2	26-35	101	20
		89-2-3	35-72	98	23
Pawnee clay loam:					
950 feet north of the southwest corner of the NW¼ sec. 18, T. 10 S., R. 16 E. (Modal)	Glacial till.	S-64-Kans-			
		89-31-1	0-12	78	20
		89-31-2	15-27	97	22
		89-31-3	35-60	99	22
800 feet south of the northwest corner of sec. 18, T. 10 S., R. 16 E. (Nonmodal; stone line at a depth of 17 to 22 inches and a concentration of calcium carbonate at a depth of 60 to 80 inches)	Glacial till.	S-64-Kans-			
		89-32-1	0-12	98	19
		89-32-2	22-36	102	18
		89-32-3	36-60	106	20
		89-32-4	60-80	111	17
1,300 feet east of the northwest corner of sec. 8, T. 10 S., R. 16 E. (Nonmodal, gray-coated peds in lower A horizon)	Glacial till.	S-64-Kans-			
		89-33-1	0-14	106	16
		89-33-2	17-28	96	22
		89-33-3	38-60	102	21
		89-33-4	60-84	112	16

[1] Based on AASHO Designation: T 99-57.

[2] Mechanical analyses according to AASHO Designation T 88-57 (*1*) with the following variations: (1) all material is ovendried at 230° F. and crushed in a laboratory crusher, (2) the sample is not soaked prior to dispersion, (3) sodium silicate is used as a dispersing agent, and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2; the maximum time is 15 minutes, and the minimum is 1 minute. Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size

test data

Roads (BPR) in accordance with standard procedures of the American Association of State Highway Officials (AASHO)]

Mechanical analysis [2]								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than—							
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified [3]
100	----------	99	98	81	55	27	18	37	15	A-6(10)	CL
100	----------	----------	99	84	66	44	35	63	36	A-7-6(20)	CH
100	----------	----------	99	83	60	28	18	45	22	A-7-6(14)	CL
100	----------	99	98	85	61	36	29	52	27	A-7-6(17)	CH
100	----------	----------	99	89	75	52	44	69	47	A-7-6(20)	CH
100	----------	----------	99	89	71	38	31	57	38	A-7-6(19)	CH
100	----------	98	96	82	64	42	37	59	40	A-7-6(20)	CH
100	----------	99	98	78	49	27	21	41	17	A-7-6(11)	ML-CL
100	----------	99	98	81	66	44	35	55	32	A-7-6(19)	CH
100	----------	99	98	83	60	32	24	50	20	A-7-5(14)	ML-CL
100	----------	----------	99	88	71	47	39	58	33	A-7-6(20)	CH
100	----------	99	98	87	71	46	39	58	35	A-7-6(20)	CH
100	----------	----------	99	72	48	29	19	47	22	A-7-6(14)	CL
100	----------	----------	99	85	66	43	34	65	42	A-7-6(20)	CH
----------	100	----------	99	84	66	38	27	52	29	A-7-6(18)	CH
100	----------	99	95	65	44	23	15	42	16	A-7-6(11)	ML-CL
100	99	98	95	75	61	38	28	50	27	A-7-6(17)	CL
100	----------	99	96	79	68	51	40	66	42	A-7-6(20)	CH
100	97	93	85	70	47	23	15	40	15	A-6(10)	ML-CL
100	96	92	85	73	60	38	32	52	31	A-7-6(18)	CH
100	93	88	79	68	56	42	37	71	50	A-7-6(20)	CH
100	94	85	71	56	36	20	13	40	15	A-6(9)	ML-CL
100	91	87	76	64	55	40	35	62	41	A-7-6(20)	CH
100	93	86	73	63	50	35	28	48	31	A-7-6(17)	CL
100	93	86	73	60	47	26	21	40	23	A-6(13)	CL
100	94	87	73	59	41	20	13	36	15	A-6(10)	CL
100	93	88	80	67	58	46	42	74	52	A-7-6(20)	CH
100	93	87	75	64	53	36	31	59	40	A-7-6(20)	CH
100	93	87	74	65	52	33	25	41	25	A-7-6(14)	CL

fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for naming textural classes for soils.

[3] Soil Conservation Service and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification. An example of a borderline classification obtained by this use is ML-CL.

TABLE 5.—*Estimated engineering*

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Dwight (Dm, Ds, Dw) (For properties of Martin soil in mapping unit Dm, see the Martin series.)	3–7	0–5	Silty clay loam	CL	A–6
		5–80	Clay and silty clay	CH	A–7–6
Elmont (El, Em, En, Eo, Ep)	3–5	0–16	Silt loam and silty clay loam.	CL, ML–CL	A–6 or A–4
		16–42	Silty clay loam	CL	A–6
		42–80	Silty clay	CH	A–7–5
Eudora:					
Et, Eu, Ev, Ew (For properties of the Kimo soils in mapping units Ev and Ew, see the Kimo series.)	10+	0–42	Silt loam	ML	A–4
		42–65	Loamy fine sand	SM	A–1–b
Es (sandy variant)	10+	0–51	Sandy loam	SM	A–2–4
		51–78	Clay loam	CL, ML–CL	A–7–6
Gymer (Gm, Gy)	8+	0–8	Silt loam	CL	A–6
		8–80	Silty clay loam	CL	A–7
Kennebec:					
Kb	10+	0–48	Silt loam	CL	A–6
		48–80	Silty clay loam	CL	A–6
Kc	10+	0–68	Silty clay loam	CL	A–6
		68–75	Silty clay	CH	A–7–6
Kimo:					
Km	10+	0–24	Silty clay loam and silty clay.	CL, CH	A–7–6
		24–60	Very fine sandy loam and silt loam.	SM, ML	A–4
Ko (depressional)	10+	0–30	Silty clay	CH	A–7–6
		30–60	Silt loam	ML	A–4
Kipson-Sogn complex (Ks) (For properties of the Sogn soil in this mapping unit, see the Sogn series.)	5–2	0–17	Silty clay loam	CL	A–6
		17–36	Platy shale.		
Konawa (Ku, Kw)	8+	0–24	Fine sandy loam	SM or ML	A–4
		24–63	Clay loam and sandy clay loam.	CL	A–6
Labette (La, Lb, Lc)	2–6	0–13	Silty clay loam	ML–CL or CL	A–7–5
		13–46	Silty clay	CH	A–7–6
		46	Limestone.		
Ladysmith (Ld, Lm, Ls)	8+	0–10	Silty clay loam	CL or CH	A–6 or A–7
		10–32	Silty clay	CH	A–7–6
		32–72	Silty clay	CL or CH	A–7–6
Martin:					
Mb, Mc, Me, Mf, Mh	4+	0–17	Silty clay loam	CL, ML–CL	A–7–6
		17–72	Silty clay	CH	A–7–6
		72–96	Soft shale.		
Mk	3–10	0–72	Silty clay	CH	A–7–6
Morrill (Mm, Mn, Mo, Mp)	8+	0–70	Clay loam	ML–CL	A–6
Muir (Mr)	10+	0–20	Silt loam	CL, ML–CL	A–6
		20–62	Silty clay loam	CL	A–6
		62–80	Silt loam	CL, ML–CL	A–6
Pawnee (Pa, Pc, Pe, Pn)	8+	0–19	Clay loam	ML–CL	A–6
		19–79	Clay	CH	A–7–6

properties of the soils

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4	No. 10	No. 200				
			Inches per hour	*Inches per inch of soil*	*pH*	
100	100	90–95	0. 05–0. 20	0. 18	6. 1–6. 5	Moderate.
100	100	90–95	<0. 05	. 16	7. 4–8. 4	High.
100	100	70–90	0. 63–2. 00	. 19	5. 6–6. 5	Low to moderate.
100	100	90–95	0. 20–0. 63	. 19	5. 6–6. 5	Moderate.
100	100	90–95	0. 05–0. 20	. 16	6. 1–7. 3	High.
100	100	70–90	0. 63–2. 00	. 19	7. 4–8. 4	Low.
100	100	15–25	2. 00–6. 30	. 06	7. 4–8. 4	Low.
100	100	25–35	2. 00–6. 30	. 13	6. 6–7. 8	Low.
100	100	70–80	0. 20–0. 63	. 18	7. 4–8. 4	Moderate.
100	100	70–90	0. 20–0. 63	. 19	5. 6–6. 5	Moderate.
100	100	90–95	0. 20–0. 63	. 19	5. 6–6. 5	Moderate to high.
100	100	70–90	0. 63–2. 00	. 19	6. 1–7. 3	Moderate.
100	100	90–95	0. 20–0. 63	. 18	6. 1–7. 3	Moderate.
100	100	90–95	0. 20–0. 63	. 19	6. 1–7. 3	Moderate.
100	100	90–95	<0. 05	. 16	7. 4–7. 8	High.
100	100	90–95	0. 05–0. 20	. 18	6. 6–7. 3	High.
100	100	45–60	0. 63–2. 00	. 13	6. 6–7. 8	Low.
100	100	90–95	<0. 05	. 16	6. 6–7. 3	High.
100	100	90–95	0. 63–2. 00	. 19	6. 6–7. 8	Low.
100	100	90–95	0. 20–0. 63	. 19	7. 4–8. 4	Moderate.
100	100	40–55	2. 00–6. 30	. 13	5. 1–6. 0	Low.
100	100	70–80	0. 20–0. 63	. 18	5. 1–6. 0	Moderate.
100	100	95–99	0. 20–0. 63	. 19	5. 6–6. 5	Moderate.
100	100	95–99	0. 05–0. 20	. 16	6. 1–7. 3	High.
100	100	95–99	0. 20–0. 63	. 19	5. 6–6. 5	Moderate.
100	100	95–99	<0. 05	. 16	6. 1–7. 0	High.
100	100	95–99	0. 05–0. 20	. 19	7. 0–7. 8	High.
100	100	90–95	0. 20–0. 63	. 19	5. 6–6. 5	High.
100	100	90–95	0. 05–0. 20	. 16	6. 1–7. 8	High.
100	100	90–95	0. 05–0. 20	. 16	6. 1–7. 8	High.
95–100	95–100	70–80	0. 20–0. 63	. 18	5. 6–6. 5	Moderate.
100	100	70–90	0. 63–2. 00	. 18	5. 6–6. 5	Moderate.
100	100	90–95	0. 20–0. 63	. 19	5. 6–6. 5	Moderate.
100	100	70–90	0. 63–2. 00	. 18	6. 6–7. 8	Moderate.
95–100	90–95	70–80	0. 20–0. 63	. 18	5. 6–6. 0	Moderate.
95–100	90–95	70–85	0. 05–0. 20	. 16	5. 6–6. 5	High.

TABLE 5.—*Estimated engineering*

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification: USDA texture	Unified	AASHO
	Feet	*Inches*			
Reading (Re)	10+	0–70	Silty clay loam	CL	A–6 or A–7
Sarpy:					
Sa	10+	0–60	Fine sand	SM	A–2
Se	10+	0–7	Fine sandy loam	SM or ML	A–4
(For properties of the Eudora soil in this mapping unit, see the Eudora series.)		7–66	Fine sand	SM	A–2
Sharpsburg (Sg, Sh)	8+	0–15	Silty clay loam	ML or CL	A–6
		15–72	Silty clay loam	CL or CH	A–7–6
Shelby (Sk, Sm, Sn, So)	8+	0–44	Clay loam	CL	A–6
		44–80	Clay	CH or CL	A–7–6
Shellabarger (Sp, Sr, Ss)	10+	0–19	Fine sandy loam	SM, SM–SC or ML	A–4
		19–42	Sandy clay loam	SC or CL	A–4 or A–6
		42–76	Fine sandy loam	SM, SM–SC or ML	A–4
Sibleyville (St, Su)	2–4	0–14	Loam	ML–CL	A–4
		14–34	Sandy clay loam	CL or SC	A–6
		34–38	Fine sandy loam	ML–CL or SM–SC	A–4
		38	Sandstone.		
Sogn (Sv)	.5–1.5	0–10	Silty clay loam	CL	A–6
(For properties of Vinland soil in this mapping unit, see the Vinland series.)		10	Limestone.		
Vinland (Vn)	.5–2	0–15	Silty clay loam	CL	A–6
		15–36	Shale and clay beds.		
Wabash:					
Wa	10+	0–72	Silty clay	CH	A–7–6
Wb	10+	0–16	Silty clay loam	CL or CH	A–6 or A–7
		16–80	Silty clay	CH	A–7–5
Welda (We)	8+	0–12	Silt loam	ML–CL	A–4
		12–60	Silty clay	CH	A–7–5
		60–72	Silty clay loam	CL	A–6

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as a source of—: Topsoil	Sand or gravel	Material for road fill [1]	Material for subgrade [1]	Soil features affecting—: Highway location [1]	Farm ponds: Reservoir area
Dwight (Dm, Ds, Dw) (For properties of Martin soil in mapping unit Dm, see the Martin series.)	Poor	Not suitable	Poor	Poor	Very slow internal drainage; high shrink-swell potential.	Very slow permeability.

See footnote at end of table

properties of the soils—Continued

Percentage passing sieve— No. 4	No. 10	No. 200	Permeability	Available water capacity	Reaction	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH*	
100	100	90–95	0.20–0.63	.19	5.6–7.3	Moderate to high.
100	100	10–20	>6.30	.04	6.6–7.8	Low.
100	100	40–55	2.00–6.30	.13	6.6–7.8	Low.
100	100	10–20	>6.30	.04	6.6–7.8	Low.
100	100	70–90	0.63–2.00	.19	5.6–6.5	Moderate.
100	100	90–95	0.20–0.63	.19	5.6–7.3	Moderate to high.
95–100	90–95	70–80	0.20–0.63	.18	5.6–6.0	Moderate.
95–100	90–95	75–95	0.05–0.20	.16	6.1–6.5	High.
100	100	40–55	2.00–6.30	.13	5.6–6.5	Low.
100	100	40–55	0.63–2.00	.17	5.6–6.5	Low.
100	100	40–55	2.00–6.30	.13	6.1–7.3	Low.
100	100	60–75	2.00–6.30	.18	5.1–6.0	Low.
95–100	90–95	40–55	0.63–2.00	.17	5.1–6.0	Moderate.
90–95	80–90	40–55	2.00–6.30	.13	5.1–6.0	Low.
90–95	80–90	70–85	0.05–0.20	.19	6.6–7.8	Moderate to high.
90–95	80–90	70–80	0.20–0.63	.19	5.6–7.3	Moderate to high.
100	100	95–98	<0.05	.16	6.1–7.8	High.
100	100	90–95	0.05–0.20	.20	5.6–6.5	Moderate.
100	100	90–95	<0.05	.18	6.1–7.3	High.
100	100	70–90	0.20–0.63	.19	5.1–6.0	Moderate.
100	100	90–95	0.20–0.63	.17	5.1–6.0	High.
100	100	90–95	0.05–0.20	.19	6.1–6.5	Moderate.

interpretations of soils

Soil features affecting—Continued: Farm ponds—Con.: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Limitations for sewage disposal: Septic tank	Lagoon	General suitability for foundation support for low buildings
Fair to poor stability and compaction; poor shear strength; high shrink-swell potential; moderate erodibility.	Very slow permeability; some ponding in level areas.	High water-holding capacity; very low intake rate; shallow root zone; slickspots.	Gently sloping; thin surface layer, dense claypan subsoil.	Dense clay subsoil; some slickspots; difficult to establish vegetation.	Severe: Very slow permeability.	Moderate: Poor to fair fill material.	Poor: High shrink-swell potential; poor shear strength.

TABLE 6.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of— Topsoil	Sand or gravel	Material for road fill [1]	Material for subgrade [1]	Soil features affecting— Highway location [1]	Farm ponds: Reservoir area
Elmont (El, Em, En, Eo, Ep).	Good	Not suitable	Fair to good	Poor	Local seepage	Soil shallow to shale in places; possible seepage.
Eudora (Et, Eu, Ev, Ew) (For properties of Kimo soil in mapping units Ev and Ew, see the Kimo series.)	Good	Poor for sand; sand is poorly graded below a depth of 40 inches in places; sand and gravel not suitable for concrete.	Fair; erodes easily.	Fair	High erodibility; seldom floods.	Moderately rapid permeability below a depth of 40 inches.
Eudora, sandy variant (Es)	Fair; high content of sand.	Fair for sand; sand and gravel poorly graded; not suitable for concrete.	Fair; erodes easily.	Good	High erodibility; subject to local flooding.	Moderately rapid permeability in upper 40 inches.
Gymer (Gm, Gy)	Good	Not suitable	Fair	Poor	Moderate erodibility; good drainage.	Moderately slow permeability.
Kennebec (Kb, Kc)	Good	Not suitable	Fair	Poor	Occasional flooding.	Moderate permeability for unit Kb; moderately slow for Kc (clayey substratum).
Kimo (Km, Ko)	Fair	Not suitable	Fair to poor at a depth of 24 inches or less; fair below a depth of 24 inches.	Poor at a depth of 24 inches or less; fair below a depth of 24 inches.	Poor drainage; possible flooding.	Seepage rapid below a depth of 20 to 40 inches.

See footnote at end of table.

of soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal		General suitability for foundation support for low buildings
Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Septic tank	Lagoon	
Fair to good stability and compaction; fair shear strength; impervious; moderate to high shrink-swell potential; moderate erodibility.	Good drainage; gently sloping to strongly sloping.	High water-holding capacity; medium intake rate; gently sloping to strongly sloping.	No adverse features.	Seepy spots in some places.	Moderate to severe: Moderately slow permeability; gently sloping to strongly sloping; variable percolation rates.	Moderate to severe: Slopes of 3 to 12 percent.	Fair to poor: Fair bearing capacity and shear strength; moderate to high shrink-swell potential.
Poor to fair stability, compaction, and shear strength; moderately pervious; low shrink-swell potential; high erodibility; poor resistance to piping.	Good drainage; nearly level in most places.	High water-holding capacity; medium intake rate; subject to soil blowing; seldom floods.	Not needed; nearly level in most areas.	Not needed; nearly level in most areas.	Moderate to slight: Moderate permeability; slight chance of pollution.	Moderate to severe: Moderately rapid permeability below a depth of 40 inches.	Fair: Poor to fair shear strength.
Fair stability, compaction, and shear strength; low shrink-swell potential; high erodibility; moderately pervious.	Good drainage.	Medium water-holding capacity; high intake rate; subject to flooding.	Not needed; nearly level.	Not needed; nearly level.	Slight: Occasional flooding; moderately slow permeability below 51 inches.	Moderate: Moderately rapid permeability in the upper 40 inches.	Poor to fair: Fair shear strength and bearing capacity.
Fair to good stability and compaction; fair shear strength; impervious; moderate to high shrink-swell potential and erodibility.	Good drainage; gently sloping to strongly sloping.	High water-holding capacity; low intake rate; gently sloping to strongly sloping.	No adverse features.	No adverse features.	Severe to moderate: Moderately slow permeability; gently sloping to strongly. sloping.	Moderate: Slopes of 3 to 8 percent.	Fair to poor: Fair bearing capacity and shear strength; moderate to high shrink-swell potential.
Fair to good stability and compaction; fair shear strength; impervious; moderate shrink-swell potential and erodibility.	Good drainage; occasional flooding.	High water-holding capacity; medium intake rate; subject to flooding.	Not needed; nearly level.	Not needed; nearly level.	Severe: Occasional flooding.	Slight to moderate: Occasional flooding.	Fair: Fair bearing capacity and shear strength; moderate shrink-swell potential.
Upper part: Fair stability, compaction, and sheer strength; impervious; high shrink-swell potential. Substratum: Fair to poor stability, compaction, and shear strength; low shrink-swell potential; high erodibility.	Slow permeability; areas of surface ponding; outlets difficult to establish.	High water-holding capacity; low intake rate; nearly level; depressions; poor drainage.	Not needed; nearly level.	Not needed; nearly level.	Severe: Slow permeability in upper part; possible flooding.	Moderate to severe: Moderate permeability below a depth of 24 inches.	Fair to poor: Fair to poor shear strength; fair bearing capacity.

TABLE 6.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of— Topsoil	Sand or gravel	Material for road fill [1]	Material for subgrade [1]	Soil features affecting— Highway location [1]	Farm ponds: Reservoir area
Kipson (Ks) (For properties of Sogn soil in this mapping unit, see the Sogn series.)	Poor	Not suitable	Fair	Poor	Soils shallow to shale; high calcium carbonate content.	Soils shallow to shale; possible seepage.
Konawa (Ku, Kw)	Good	Not suitable	Fair; erodes easily.	Fair at a depth of 24 inches or less; poor below a depth of 24 inches.	Moderate erodibility; well drained.	Moderately slow permeability.
Labette (La, Lb, Lc)	Good	Not suitable	Fair	Poor	Good drainage; limestone within a depth of 2 to 6 feet.	Soils moderately deep to limestone; possible seepage.
Ladysmith (Ld, Lm, Ls)	Good	Not suitable	Fair	Poor; high shrink-swell potential.	High plasticity; high shrink-swell potential.	Very slow permeability.
Martin (Mb, Mc, Me, Mf, Mh, Mk).	Good	Not suitable	Fair	Poor	Local seepage; plastic material; high shrink-swell potential.	Soils shallow to bedrock in a few areas; seepage possible.

See footnote at end of table.

of soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal		General suitability for foundation support for low buildings
Farm ponds—Con.: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Septic tank	Lagoon	
Fair to good stability and compaction; fair to poor shear strength; impervious; high shrink-swell potential; limited fill material.	Soils shallow to shale; well drained; some local seepage; gently sloping to steep.	Low water-holding capacity; low intake rate; shallow to shale; gently sloping to steep.	Soils shallow to shale; sloping to steep.	Shale within a depth of 10 to 20 inches; high calcium carbonate content; difficult to establish vegetation.	Severe: Shale within a depth of 20 inches.	Severe: Shale within a depth of 20 inches inches; 5 to 15 percent slopes.	Good: Shale within a depth of 20 inches.
Fair to poor stability and compaction; fair shear strength; impervious; moderate to high shrink-swell potential and erodibility.	Good drainage; gently sloping to strongly sloping.	Medium to high-water-holding capacity; medium intake rate; gently sloping to strongly sloping; moderate erodibility.	Channels subject to excessive siltation; gently sloping to strongly sloping.	Moderate erodibility; difficult to establish vegetation; gullies easily.	Moderate to severe: Gently sloping to strongly sloping; moderately slow permeability.	Severe to moderate: Slopes of 4 to 12 percent.	Fair to poor: Fair bearing capacity and shear strength; moderate to high shrink-swell potential.
Fair to poor stability, compaction, and shear strength; impervious; moderate to high shrink-swell potential; moderate erodibility.	Good drainage; nearly level to gently sloping; bedrock at a depth of 2 to 6 feet.	Medium to high water-holding capacity; low intake rate; nearly level to gently sloping; moderately deep root zone.	Rock outcrops in a few areas.	Rock outcrops in a few areas.	Severe: Slow permeability; variable percolation rate; shalow to bedrock in a few areas.	Severe to moderate: Slopes of 1 to 6 percent; bedrock within a depth of 2 to 6 feet.	Poor on soil because of high shrink-swell potential; good on limestone.
Fair to poor stability and compaction; fair to poor shear strength; impervious; high shrink-swell potential; moderate erodibility.	Very slow permeability; slow runoff on nearly level areas.	High water-holding capacity; low intake rate; nearly level to gently sloping.	Nearly level to gently sloping; dense clay subsoil.	Dense clay subsoil; difficult to establish vegetation.	Severe: Very slow permeability.	Moderate: Fair to poor fill material.	Fair to poor: Fair to poor shear strength and bearing capacity; high shrink-swell potential.
Fair to poor stability and compaction; poor shear strength; impervious; high shrink-swell potential; moderate erodibility.	Slow permeability; gently sloping to strongly sloping; some local seepage.	High water-holding capacity; low intake rate; gently sloping to strongly sloping.	Outcrops of rocks or shale in a few areas; some local seepage.	Some local seepage; shallow over bedrock in some areas.	Severe: Slow permeability; some local seepage; variable percolation rate.	Moderate to severe: Slopes of 1 to 11 percent.	Poor: Poor shear strength; high shrink-swell potential.

TABLE 6.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand or gravel	Material for road fill [1]	Material for subgrade [1]	Highway location [1]	Farm ponds — Reservoir area
Morrill (Mm, Mn, Mo, Mp).	Good; fair in subsoil.	Poor for gravel; local gravel pockets; not suitable for sand.	Good	Fair	Good drainage; moderate shrink-swell potential.	Gravel pockets occur in a few places and cause rapid seepage.
Muir (Mr)	Good in surface layer and subsoil.	Not suitable	Good	Fair	Good drainage; high erodibility.	Moderately slow permeability.
Pawnee (Pa, Pc, Pe, Pn)	Good	Poor for gravel; possible local gravel pockets.	Fair	Poor; high shrink-swell potential.	Plastic subsoil; high shrink-swell potential.	Slow permeability
Reading (Re)	Good	Not suitable	Good to fair	Poor	Moderate to high shrink-swell potential.	Moderately slow permeability.
Sarpy (Sa, Se) (For properties of Eudora soil in mapping unit Se, see the Eudora series.)	Poor; high content of sand.	Good for sand; poorly graded; not suitable for concrete.	Poor; erodes easily.	Good if confined.	Hazard of soil blowing; occasional flooding.	Rapid permeability.
Sharpsburg (Sg, Sh)	Good	Not suitable	Good to fair	Poor	Moderate to high shrink-swell potential.	Moderately slow permeability.

See footnote at end of table.

of soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal		General suitability for foundation support for low buildings
Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Septic tank	Lagoon	
Fair to good stability and compaction; fair to poor shear strength; impervious; moderate shrink-swell potential and erodibility.	Good drainage; gently sloping to strongly sloping.	High water-holding capacity; low intake rate; gently sloping to strongly sloping.	No adverse features.	Sand or gravel in pockets in some areas.	Moderate to severe: Moderately slow permeability.	Moderate to severe: Slopes of 3 to 12 percent.	Fair to poor: Moderate shrink-swell potential; fair to poor shear strength and bearing capacity.
Fair stability and compaction; poor to fair shear strength; slightly pervious; moderate shrink-swell potential; high erodibility; fair to poor resistance to piping.	Good drainage; nearly level.	High water-holding capacity; medium intake rate; nearly level; deep.	Not needed; nearly level.	Not needed; nearly level.	Moderate to severe: Moderately slow permeability.	Moderate to slight: Fair to poor fill material.	Fair to poor: Fair to poor shear strength and bearing capacity.
Fair to poor stability and compaction; impervious; poor shear strength; high shrink-swell potential; moderate erodibility.	Slow permeability; moderately good to good drainage; gently sloping to strongly sloping.	High water-holding capacity; low intake rate; some slickspots; gently sloping to strongly sloping.	No adverse features.	Clay subsoil; difficult to establish vegetation.	Severe: Slow permeability.	Moderate to severe: Slopes of 1 to 12 percent; poor stability as fill material.	Poor: Poor shear strength; high shrink-swell potential.
Fair to good stability and compaction; fair shear strength; impervious; moderate to high shrink-swell potential; moderate erodibility.	Good drainage; nearly level; infrequent flooding.	High water-holding capacity; low intake rate; nearly level; seldom floods.	Not needed; nearly level.	Not needed; nearly level.	Severe to moderate: Moderately slow permeability; seldom floods.	Slight	Fair to poor: Moderate to high shrink-swell potential; fair shear strength and bearing capacity.
Poor stability and compaction; fair to good shear strength; pervious; high erodibility; poor resistance to piping; low shrink-swell potential.	Sandy soil; nearly level; occasional flooding.	Low water-holding capacity; high intake rate; subject to soil blowing; occasional flooding.	Not needed; nearly level.	Not needed; nearly level.	Severe: Pollution hazard.	Severe: High permeability; pollution hazard.	Good.
Fair to poor stability, compaction, and shear strength; impervious; moderate erodibility; moderate to high shrink-swell potential.	Good drainage; gently sloping to moderately sloping.	High water-holding capacity; low intake rate; gently sloping to moderately sloping.	No adverse features.	No adverse features.	Severe: Moderately slow permeability.	Moderate to slight: Slopes of 1 to 6 percent.	Fair to poor: Moderate to high shrink-swell potential; poor to fair shear strength.

TABLE 6.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand or gravel	Material for road fill [1]	Material for subgrade [1]	Highway location [1]	Farm ponds: Reservoir area
Shelby (Sk, Sm, Sn, So)	Good	Poor for gravel; local gravel pockets; not suitable for sand.	Fair	Poor	Good drainage; moderate to high shrink-swell potential.	Seepage normally slow but is rapid where gravel pockets occur.
Shellabarger (Sp, Sr, Ss)	Fair	Not suitable	Fair; erodes easily.	Fair	High erodibility on unprotected embankments.	Moderate seepage.
Sibleyville (St, Su)	Fair	Not suitable	Good	Fair	Sandstone or shale within a depth of 40 inches; some local seepage.	Soils moderately deep to shale or sandstone; rapid seepage in some places.
Sogn (Sv) (For properties of Vinland soil in the mapping unit, see the Vinland series.)	Not suitable	Not suitable	Fair to good	Poor	Limestone within a depth of 15 inches; local seepage.	Soils shallow to limestone; rapid seepage in some places.
Vinland (Vn)	Fair	Not suitable	Fair	Poor	Shale within a depth of 20 inches.	Soils shallow over shale; rapid seepage in some places.

See footnote at end of table.

of soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal		General suitability for foundation support for low buildings
Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Septic tank	Lagoon	
Fair stability and compaction; poor to fair shear strength; impervious; moderate erodibility; moderate to high shrink-swell potential.	Good drainage; gently sloping to strongly sloping.	High water-holding capacity; low intake rate; gently sloping to strongly sloping.	No adverse features.	No adverse features.	Moderate to severe: Moderately slow permeability.	Moderate to severe: Slopes of 2 to 12 percent.	Fair to poor: Moderate to high shrink-swell potential; poor to fair shear strength.
Fair stability and shear strength; fair to good compaction; moderately pervious; high erodibility; low to moderate shrink-swell potential.	Good drainage; gently sloping to strongly sloping.	Medium water water-holding capacity; medium intake rate; gently sloping to strongly sloping; high erodibility.	Loamy soils; channels subject to excessive siltation; highly erodible.	High erodibility; difficult to establish vegetation.	Moderate: Slopes of 3 to 12 percent; moderate permeability.	Severe to moderate: Slopes of 3 to 12 percent; moderate permeability.	Fair to good: Fair shear strength; low shrink-swell potential.
Fair to good stability and compaction; fair shear strength; impervious; moderate to high erodibility; moderate shrink-swell potential; fill material limited in amount.	Good drainage; gently sloping to strongly sloping; some local seepage; bedrock within a depth of 20 to 40 inches.	Medium water-holding capacity; medium intake rate; gently sloping to strongly sloping; moderate erodibility; moderately deep.	Moderate soil depth; channels subject to excessive siltation; erodes easily.	Moderate soil depth; erodes easily; low fertility; possible local seepage; difficult to establish vegetation.	Moderate: Bedrock within a depth of 2 to 4 feet.	Severe: Slopes of 3 to 10 percent; bedrock within a depth of 2 to 4 feet.	Fair on soil; fair shear strength; moderate shrink-swell potential; good on bedrock.
Fill material very limited in amount; fair stability, compaction, and shear strength; impervious; moderate to high shrink-swell potential; moderate erodibility.	Soils shallow over limestone; gently sloping to strongly sloping; some local seepage.	Low water-holding capacity; low intake rate; gently sloping to strongly sloping; shallow to limestone.	Soils shallow to limestone; hard rock within a depth of 15 inches.	Hard rock within a depth of 15 inches; difficult to construct and to establish vegetation.	Severe: Hard rock within a depth of 15 inches.	Severe: Hardrock within a depth of 15 inches.	Good: Hard rock within a depth of 15 inches.
Fill material limited in amount; fair stability, compaction, and shear strength; impervious; moderate to high shrink-swell potential.	Soils shallow to shale; some local seepage; gently sloping to strongly sloping.	Low water-holding capacity; low intake rate; shallow to shale.	Soils shallow to shale; shale within a depth of 20 inches.	Shale within a depth of 20 inches; low fertility; difficult to establish vegetation.	Severe: Shale within a depth of 20 inches.	Severe: Soils shallow to shale; 4 to 10 percent slopes.	Good: Shale within a depth of 20 inches.

TABLE 6.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand or gravel	Material for road fill [1]	Material for subgrade [1]	Highway location [1]	Farm ponds: Reservoir area
Wabash (Wa, Wb)	Poor to fair	Not suitable	Poor	Poor	Poor drainage; high shrink-swell potential; hazard of flooding.	Very low seepage
Welda (We)	Good	Not suitable	Good to fair	Poor	Good drainage; high shrink-swell potential.	Low seepage

[1] Estimates made with the assistance of C. W. HECKATHORN, engineer of soils, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission.

Terraces and diversions are not needed on many soils in the county, and other soils have no features that impair installation of these structures. Features unfavorable for their installation are a thin surface layer, a claypan subsoil, shale near the surface, and rock outcrops.

Where waterways are needed, they are affected by seepage, pockets of sand and gravel, and bedrock near the surface.

In table 6 the suitability of the soils for supporting foundations of buildings less than three stories high is rated *poor*, *fair*, and *good*. The ratings are for the substratum because it generally is the base for foundations. Suitability was rated on the basis of the Unified classification of the soils and their shear strength, bearing capacity, and shrink-swell potential. In rating the soils, engineers and others should not apply specific values to the estimates given for bearing capacity.

Use of Soils for Recreational Sites [8]

Shawnee County is easily accessible by automobile for a large number of people seeking recreation. National Interstate Highway No. 70 connects the eastern and western parts of Kansas, and the Kansas Turnpike connects Wichita, Topeka, Lawrence, and Kansas City. Topeka, the capital of Kansas, attracts large numbers of visitors and has many opportunities for recreation. Topeka is in the east-central part of the county.

The limitations that affect the suitability of the soils used as recreational sites are rated in table 7. Made land has such variable properties that it is not included.

[8] Prepared by JACK W. WALSTROM, biologist, Soil Conservation Service.

The ratings in table 7 are *slight*, *moderate*, *severe*, and *very severe*. A rating of slight means that the soil has few or no limitations for the use specified or that the limitations can be easily overcome. A rating of moderate indicates that some planning and engineering practices are needed to overcome the limitations. A rating of severe indicates that the soil is poorly suited to the use specified and that intensive engineering practices, as well as a large investment, are needed to overcome the limitations. A rating of very severe indicates that the soil is very poorly suited to the specified use and that practices necessary to overcome the limitations are not economically feasible.

These four ratings give general information regarding suitability, but a specific building site generally requires a detailed investigation at the site. Discussed in the following paragraphs are the properties that were considered when the limitations to use of soils for the specified recreational sites were rated.

Sites for cottages and utility buildings.—In this column the soils were rated according to their limitations for use as sites for cottages, washrooms, bathhouses, picnic shelters, and service buildings. Among these limitations are drainage and flooding or ponding. Limitations of soils when used as disposal fields for septic tanks are not considered in this part of the survey but are rated in the subsection "Engineering Uses of Soils."

Intensive campsites.—These sites are used for tents, small camp trailers, and activities related to camping. The sites should be suitable for heavy foot or vehicular traffic, for they are used frequently during the camping season. The suitability of soil for producing vegetation should be considered separately in selecting sites for intensive camping.

of soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal		General suitability for foundation support for low buildings
Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Septic tank	Lagoon	
Fair to poor stability and compaction; poor shear strength; impervious; high shrink-swell potential and compressibility; moderate erodibility.	Very slow permeability; areas of surface ponding; outlets difficult to establish.	High water-holding capacity; low intake rate; nearly level; poor drainage; possible flooding.	Not needed; nearly level.	Not needed; nearly level.	Severe: Very slow permeability; possible flooding.	Moderate: Unstable fill material.	Poor: High shrink-swell potential; poor shear strength.
Fair to poor stability and compaction; poor shear strength; impervious; high shrink-swell potential and compressibility; moderate erodibility.	Good drainage; gently sloping to strongly sloping.	High water-holding capacity; low intake rate; gently sloping to strongly sloping.	No adverse features.	Clay subsoil: Difficult to establish vegetation.	Severe: Slow permeability.	Moderate to severe: Slopes of 4 to 10 percent.	Poor: High shrink-swell potential; poor shear strength.

Picnic areas.—The ratings in table 7 are based only on soil features, such as drainage and texture of the surface layer, though other factors, such as lakes, trees, or beauty of the landscape, may add to the desirability of a picnic area.

Intensive play areas.—Among these areas are playgrounds, baseball diamonds, football fields, and badminton courts. Generally required is a soil that is nearly level and has good drainage and a surface free of rocks. It is assumed that a thick vegetative cover can be established and maintained where needed.

Trails and paths.—Within this category are trails for cross-country hiking, bridle paths for horseback riding, and other sites for nonintensive uses. Generally, the soils should not need much grading or shaping. The ratings are based on soil features only and do not include other factors, such as beauty of the landscape, that are important when selecting sites for trails or paths.

Golf fairways.—Golf fairways (exclusive of roughs, hazards, traps, and greens) require soils with good trafficability, a minimum amount of coarse fragments or stones, and slopes that are not too steep. The turf may be improved by frequent applications of fertilizer and by supplemental water through irrigation.

Formation and Classification of Soils

This section explains how soils form and discusses the factors that affected the formation of soils in Shawnee County. It describes briefly the current system of soil classification and places the soil series represented in the county in some classes of that system.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on material deposited or altered by geologic forces. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body having genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of soil profile that is formed and in a few places may determine it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for soil horizon differentiation. Usually, a long time is required for the development of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

Parent material is the horizon of weathered rocks or partly weathered material from which soils are formed.

TABLE 7.—*Limitations of soils*

Soils and map symbols	Degree and kind of limitation if soils are used for—	
	Sites for cottages and utility buildings	Intensive campsites
Alluvial land: An	Severe: Flooding or ponding	Severe: Flooding or ponding
Breaks-Alluvial land complex: Bk	Severe: Flooding or ponding; slope	Severe: Flooding or ponding; slope
Broken alluvial land: Br	Severe: Flooding or ponding; slope	Severe: Flooding or ponding; slope
Dwight:		
Ds, Dw	Severe: Very slow permeability	Severe: Very slow permeability
Dm	Moderate: Slow to very slow permeability.	Moderate: Slow to very slow permeability.
Elmont:		
El, Em, En, Eo	Slight where slopes are 7 percent or less, and moderate where slopes are more than 7 percent.	Slight where slopes are 7 percent or less, and moderate where slopes are more than 7 percent.
Ep	Slight	Moderate: Moderately fine textured surface layer; severe erosion.
Eudora:		
Es	Severe: Flooding	Severe: Flooding
Et	Slight	Slight
Eu	Moderate: Slope	Moderate: Slope
Ev, Ew	Moderate: Slow surface runoff; sandy surface layer.	Severe: Sandy surface layer; slow surface runoff.
Gymer: Gm, Gy	Slight	Slight
Kennebec: Kb, Kc	Severe: Flooding or ponding	Severe: Flooding
Kimo:		
Km	Severe: Flooding or ponding; slow surface runoff.	Severe: Clayey surface layer; flooding or ponding; slow surface runoff.
Ko	Severe: Clayey surface layer; flooding or ponding; poor drainage.	Very severe: Clayey surface layer; flooding or ponding; poor drainage.
Kipson: Ks	Severe: Stoniness or rockiness; slope	Severe: Stoniness or rockiness; slope
Konawa: Ku, Kw	Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.	Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.
Labette: La, Lb, Lc	Slight	Moderate: Moderately fine textured surface layer.
Ladysmith: Ld, Lm, Ls	Slight	Moderate: Moderately fine textured surface layer; slow to very slow permeability.
Martin: Mb, Mc, Me, Mf, Mh, Mk	Slight where slopes are 7 percent or less, and moderate where slopes are more than 7 percent.	Moderate: Moderately fine textured surface layer; slow permeability.

used for recreational sites

Degree and kind of limitation if soils are used for—Continued			
Picnic areas	Intensive play areas	Trails and paths	Golf fairways
Moderate: Flooding or ponding.	Severe: Flooding or ponding	Severe: Flooding or ponding	Severe: Flooding or ponding.
Severe: Slope; flooding or ponding.	Severe: Slope; flooding or ponding.	Moderate: Slope; flooding or ponding.	Severe: Flooding or ponding; slope.
Severe: Slope; flooding	Severe: Slope; flooding or ponding.	Severe: Slope; flooding or ponding.	Severe: Flooding or ponding.
Moderate: Moderately fine textured surface layer. Moderate: Moderately fine textured surface layer.	Severe: Very slow permeability. Severe: Slow to very slow permeability; moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer. Moderate: Moderately fine textured surface layer.	Severe: Very slow permeability. Moderate: Slow to very slow permeability.
Slight where slopes are 7 percent or less, and moderate where slopes are more than 7 percent.	Moderate or severe: Moderately fine textured surface layer; slope. Moderate where slopes are 7 percent or less, and severe where slopes are more than 7 percent.	Slight	Slight where slopes are 7 percent or less, and moderate where slopes are more more than 7 percent.
Moderate: Moderately fine textured surface layer; severe erosion.	Moderate: Moderately fine textured surface layer; slope.	Moderate: Moderately fine textured surface layer; severe erosion.	Severe: Severe erosion.
Moderate: Flooding Slight Moderate: Slope Moderate: Sandy surface layer; slow surface runoff.	Moderate: Flooding Slight Severe: Slope Moderate: Sandy surface layer; slow surface runoff.	Slight Slight Slight Slight	Moderate: Sandy surface layer. Slight. Moderate: Slope. Moderate: Sandy surface layer.
Slight	Moderate: Slope	Slight	Slight.
Moderate: Flooding or ponding.	Moderate: Flooding or ponding.	Slight	Slight.
Moderate: Clayey surface layer.	Severe: Clayey surface layer; flooding or ponding; slow surface runoff.	Moderate: Clayey surface layer.	Moderate: Clayey surface layer; slow surface runoff.
Severe: Clayey surface layer; poor drainage; flooding or ponding.	Very severe: Clayey surface layer; flooding or ponding; poor drainage.	Severe: Clayey surface layer; flooding or ponding.	Severe: Clayey surface layer; flooding or ponding; poor drainage.
Moderate: Moderately fine textured surface layer; slope.	Very severe: Stoniness or rockiness; slope.	Moderate: Stoniness or rockiness; moderately fine textured surface layer.	Severe: Stoniness or rockiness.
Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.	Moderate where slopes are 8 percent or less, and severe where slopes are more than 8 percent.	Slight	Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.
Moderate: Moderately fine textured surface layer.	Moderate: Slope; moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer.
Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer; slow permeability; slope.	Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer; very slow permeability.
Moderate: Moderately fine textured surface layer.	Moderate or severe: Moderately fine textured surface layer; slope. Moderate where slopes are 7 percent or less, and severe where slopes are more than 7 percent.	Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer; moderate where slopes are more than 7 percent.

TABLE 7.—*Limitations of soils used*

Soils and map symbols	Degree and kind of limitation if soils are used for—	
	Sites for cottages and utility buildings	Intensive campsites
Morrill: Mm, Mn, Mo	Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.	Moderate: Moderately fine textured surface layer.
Mp	Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.	Moderate: Gravelly surface layer
Muir: Mr	Slight	Slight
Pawnee: Pa, Pc, Pe, Pn	Slight where slopes are 7 percent or less, and moderate where slopes are more than 7 percent.	Moderate: Moderately fine textured surface layer.
Reading: Re	Slight	Moderate: Moderately fine textured surface layer.
Riverwash: Rv	Very severe: Flooding	Very severe: Flooding
Sarpy: Sa	Severe: Sandy surface layer; flooding	Severe: Sandy surface layer; flooding
Se	Moderate: Sandy surface layer; flooding	Severe: Sandy surface layer; flooding
Sharpsburg: Sg, Sh	Slight	Moderate: Moderately fine textured surface layer.
Shelby: Sk, Sm, Sn, So	Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.	Moderate: Moderately fine textured surface layer.
Shellabarger: Sp, Sr, Ss	Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.	Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.
Sibleyville: St, Su	Slight where slopes are 7 percent or less, and moderate where slopes are more than 7 percent.	Slight where slopes are 7 percent or less, and moderate where slopes are more than 7 percent.
Sogn: Sv	Moderate: Rockiness or stoniness	Moderate: Rockiness or stoniness; moderately fine textured surface layer.
Stony steep land: Sw	Severe: Slope; rockiness or stoniness	Severe: Slope; rockiness or stoniness
Vinland: Vn	Moderate: Shallow soil	Moderate: Moderately fine textured surface layer.
Wabash: Wa	Severe: Poor drainage; flooding or ponding.	Severe: Poor drainage; clayey surface layer.
Wb	Moderate: Somewhat poor drainage; flooding or ponding.	Moderate: Moderately fine textured surface layer; somewhat poor drainage.
Welda: We	Slight	Slight

for recreational sites—Continued

Degree and kind of limitation if soils are used for—Continued			
Picnic areas	Intensive play areas	Trails and paths	Golf fairways
Moderate: Moderately fine textured surface layer.	Moderate or severe: Moderately fine textured surface layer; slope. Moderate where slopes are 8 percent or less, and severe where slopes are more than 8 percent.	Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer; moderate where slopes are more than 8 percent.
Moderate: Gravelly surface layer.	Severe: Gravelly surface layer; slope.	Moderate: Gravelly surface layer.	Moderate: Gravelly surface layer.
Slight	Slight	Slight	Slight.
Moderate: Moderately fine textured surface layer.	Moderate or severe: Moderately fine textured surface layer; slope. Moderate where slopes are 7 percent or less, and severe where slopes are more than 7 percent.	Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer; moderate where slopes are more than 7 percent.
Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer.
Severe: Flooding	Very severe: Flooding	Severe: Flooding	Very severe: Flooding.
Severe: Sandy surface layer	Severe: Sandy surface layer; flooding.	Severe: Sandy surface layer	Severe: Sandy surface layer.
Slight	Moderate: Sandy surface layer; flooding.	Slight	Moderate: Sandy surface layer; flooding.
Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer; slope.	Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer.
Moderate: Moderately fine textured surface layer.	Moderate or severe: Moderately fine textured surface layer; slope. Moderate where slopes are 8 percent or less, and severe where slopes are more than 8 percent.	Moderate: Moderately fine textured surface layer.	Slight or moderate: Moderately fine textured surface layer. Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.
Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.	Moderate where slopes are 8 percent or less, and severe where slopes are more than 8 percent.	Slight	Slight where slopes are 8 percent or less, and moderate where slopes are more than 8 percent.
Slight where slopes are 7 percent or less, and moderate where slopes are more than 7 percent.	Moderate where slopes are 7 percent or less, and severe where slopes are more than 7 percent.	Slight	Slight where slopes are 7 percent or less, and moderate where slopes are more than 7 percent.
Moderate: Rockiness or stoniness; moderately fine textured surface layer.	Very severe: Slope; rockiness or stoniness.	Moderate: Rockiness or stoniness; moderately fine textured surface layer.	Severe: Rockiness or stoniness; slope.
Severe: Slope; rockiness or stoniness.	Very severe: Slope; rockiness or stoniness.	Severe: Rockiness or stoniness; slope.	Very severe: Rockiness or stoniness; slope.
Moderate: Moderately fine textured surface layer.	Severe: Slope; shallow soil	Moderate: Moderately fine textured surface layer.	Moderate: Moderately fine textured surface layer.
Severe: Poor drainage; clayey surface layer. Moderate: Somewhat poor drainage; moderately fine textured surface layer.	Severe: Poor drainage; clayey surface layer. Severe: Somewhat poor drainage; moderately fine textured surface layer.	Severe: Poor drainage; clayey surface layer. Moderate: Somewhat poor drainage; moderately fine textured surface layer.	Severe: Clayey surface layer; poor drainage. Moderate: Moderately fine textured surface layer; somewhat poor drainage.
Slight	Severe: Slope	Slight	Slight.

Weathering of rocks takes place through the processes of freezing and thawing, abrasion and soil blowing, water and glaciers acting on the soil, and by chemical processes.

In Shawnee County the soils formed in materials derived from Upper Pennsylvanian limestone and shale, Kansan till or outwash from till, Loveland loess and Peorian silts, and recent alluvium.

Upper Pennsylvanian limestone and shale.—This is the bedrock from which residual soil materials in Shawnee County weathered. It consists of limestone and thick shale. This bedrock ranges from the Kanwaka shale, which crops out along the Wakarusa River in the southeastern part of the county, to the Aspinwall limestone in the base of the Permian system in the northwestern part.

The Martin, Elmont, Sibleyville, Labette, Sogn, Kipson, and Vinland soils formed in residuum weathered from bedrock. Bedrock crops out on all the slopes in the southern and southwestern parts of the county and on most slopes in the glaciated northern and eastern parts.

Soils, such as the Martin, formed in material weathered from silty and clayey shale. The Sibleyville and Elmont soils are coarser textured than the moderately fine textured Martin soils and formed in material weathered from sand and silty shale. Labette soils formed in soil materials weathered from limestone, or calcareous shale that is closely associated with limestone.

Kansan till.—During the Kansan stage the glacier covered parts of Shawnee County. The uplands north of the Kansas River are mantled by glacial till that ranges from a thin veneer of clayey soil to more than 40 feet of typical till. Because erosion followed deposition, the till is thickest and most common on crests of hills. In many places north of the Kansas River, the till is thick enough and continuous enough to modify the common bedrock topography (*4*). Thin and discontinuous deposits of glacial till are as far south as the Wakarusa River. They extend from U.S. Highway No. 75 eastward to the county line, and near the western county line, as far south as Mission Creek.

The Kansan till is deeply weathered. Most of the till is characterized by a fairly high content of clay and silt. The depth to which the till is leached is variable but generally does not exceed 15 feet. In most places the upper part of the till is brownish in color and contains varying amounts of cobblestones and pebbles of granite, chert, quartz, and various kinds of metamorphic rocks.

In most places the glacial soils in Shawnee County are in the Pawnee series, and they reflect the high clay content of the glacial till. The Shelby and Morrill soils developed in areas where the till is less clayey and generally contains more glacial sand and gravel.

Loveland loess and Peorian silts.—Following deposition of the Kansan till, layers of loess and alluvial silts were deposited. Most of the Loveland loess in which Gymer soils formed are in the uplands near the Kansas River. The Peorian silts cover a wider area, but the thickest deposits are south of the Kansas River near Tecumseh, where they are about 10 feet thick. The Sharpsburg soils, which formed in Peorian silts, are easy to farm and fairly high in fertility.

On the ridgetops in the uplands away from the Kansas River, the mantle of Peorian loess is thin. It is underlain by Kansan till in the northern part of the county and by clay beds of undetermined origin in the southern part. The Ladysmith and Dwight soils developed in these areas. They have a dense clay subsoil.

Recent alluvium.—Recently deposited alluvium is the parent material for all soils formed on the flood plains and stream terraces along all the major streams in the county. These soil materials range from sands and loamy sands on the first bottom of the Kansas River to dense clay in the slack-water areas on the stream terraces. The Sarpy soils developed in coarse-textured soil material adjacent to the Kansas River. The Wabash soils formed in the finest textured alluvium. The Eudora soils formed in coarse silty material, but the Muir and Reading soils formed in medium or moderately fine textured material.

Climate

Climate influences both physical and chemical weathering processes and the biological forces at work in the parent material. The downward movement of water is a major factor in transforming the parent material into a soil that has distinct horizons. The amount of water that percolates through the soils depends mainly on temperature, type and intensity of precipitation, and humidity and to a lesser extent on relief and nature of the soil material. Soil-forming processes are the most active when the soil is warm and moist. In Shawnee County these processes are most active during the warmer months. Soil structure is modified by freezing and thawing. The freezing and thawing of wet clays tend to form soils into aggregates. Alternate wetting and drying is active in the subhumid climate of the county and is an important process in creating soil structure.

Climate is an important factor in causing differences in soils over a wide region, but differences in soils as a consequence of climate in a small area such as Shawnee County are slight.

Plants and animals

Two important functions of plants and animals in the soil-forming process are the furnishing of organic matter to the soil and the bringing up of plant nutrients from the underlying layers to the surface layer. Trunks, stems, leaves, and roots of plants are the primary sources of organic matter. This organic matter modifies the color, structure, and other soil properties physically and chemically, and it creates a more favorable environment for biological activity within the soil. Burrowing animals contribute much by mixing various soil horizons and to some extent by bringing fresh material into the surface horizons. Earthworms feed on organic matter and make channels, and in this way they thoroughly mix the soil in which they live.

Most soils in Shawnee County formed under tall prairie grasses. These grasses add a great deal of organic matter to the soil, darken the surface layer, and strengthen soil structure. A few minor areas on the uplands bordering the alluvial plain of the Kansas River formed under a cover of deciduous trees. The surface layer of these soils is gray and strongly acid.

Relief

Relief influences soil formation through runoff, drainage, and other effects of water, including normal and accelerated erosion. The amount of water that moves into the soil depends partly on topography. Generally, less water enters steep soils than gently sloping soils, and more soil material is lost by erosion. Level or depressional topography generally influences the amount of moisture available, for the soil receives extra water as runoff from higher parts. Because of this additional water, the upper layers of the soil profile are gray colored or mottled. Level or gently sloping soils on uplands generally have more strongly developed profiles than the steep soils. Runoff is slowed on the level soils; and thus more water percolates through the soil, and less soil is removed from the surface.

Time

Time is required for soil formation. The length of time needed depends largely on the other factors of soil formation. Water moves through the soil profile and, gradually, soluble matter and fine particles are leached from the surface layer and deposited in the subsoil. The amount of leaching depends on how much time has elapsed and the amount of water that penetrates the soil. For example, the Eudora soils, which formed in recent alluvium, are young soils and show very little horizon development other than a slight darkening of their surface layer. Ladysmith soils, which have been exposed to soil-forming processes for thousands of years, are older and have well-defined soil horizons.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationships to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First, through classification, and then through the use of soil maps, we can apply our knowledge of soils to specific fields or other tracts of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowlege about the soils can be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in developments of the system should search the latest literature available (*8,10*). In table 8, the soil series represented in Shawnee County are placed in higher categories of the current system. The classes of the current system are briefly defined in the following paragraphs:

ORDER: Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groups. The two exceptions, Entisols and Histosols, occur in many different climates.

Table 8 lists the soil orders represented in Shawnee County—Entisols, Mollisols, and Alfisols.

Entisols are recently formed soils that do not have genetic horizons or have only the beginning of such horizons. The Entisols in Shawnee County were formerly called Alluvial soils.

Mollisols developed mainly under grass and have well-formed genetic horizons. They have a dark surface layer that is high in content of organic matter. The Mollisols in this county were formerly called Brunizems, Alluvial soils, or Lithosols.

Alfisols have a clay-enriched B horizon that is high in base saturation. They lack the dark surface layer of Mollisols and the high content of organic matter. The Alfisols in Shawnee County were formerly called Gray-Brown Podzolic soils.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborder narrows the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation.

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequnce of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans interfering with growth of roots or movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown in table 8, because it is the last word in the name of the subgroup.

SUBGROUP: Great groups are subdivided into subgroups, one that represents the central (typic) segment of the group and others, called intergrades, that have properties of one group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Hapludolls (typical Hapludolls).

FAMILY: Families are separated within the subgroup primarily on the basis of properties important to growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Additional Facts About the County

In this section the history and development and physiography, relief, and drainage of Shawnee County are discussed. Also given is information about climate, water

TABLE 8.—*Soil series classified according to the current system*

Series	Current system [1]		
	Family	Subgroup	Order
Dwight	Fine, montmorillonitic, mesic	Typic Natrustolls [2]	Mollisols.
Elmont	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Eudora	Coarse-silty, mixed, mesic	Fluventic Hapludolls	Mollisols.
Gymer	Fine, montmorillonitic, mesic	Typic Argiudolls	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kimo	Clayey over loamy, montmorillonitic, mesic	Aquic Fluventic Hapludolls	Mollisols.
Kipson	Loamy, mixed, mesic, shallow	Entic Haplustolls [2]	Mollisols.
Konawa	Fine-loamy, mixed, thermic [3]	Ultic Haplustalfs [2]	Alfisols.
Labette	Fine, montmorillonitic, mesic	Udic Argiustolls [2]	Mollisols.
Ladysmith	Fine, montmorillonitic, mesic	Pachic Argiustolls [2]	Mollisols.
Martin	Fine, mixed, mesic	Aquic Argiudolls	Mollisols.
Morrill	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Muir	Fine-silty, mixed, mesic	Pachic Haplustolls [2]	Mollisols.
Pawnee	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Reading	Fine, mixed, mesic	Typic Argiudolls	Mollisols.
Sarpy	Sandy, mixed, mesic	Typic Udipsamments	Entisols.
Sharpsburg	Fine, montmorillonitic, mesic	Typic Argiudolls	Mollisols.
Shelby	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Shellabarger	Fine-loamy, mixed, thermic [3]	Udic Argiustolls [2]	Mollisols.
Sibleyville	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Sogn	Loamy, mixed, mesic	Lithic Haplustolls [2]	Mollisols.
Vinland	Loamy, mixed, mesic, shallow	Typic Hapludolls	Mollisols.
Wabash	Fine, montmorillonitic, noncalcareous, mesic	Vertic Haplaquolls	Mollisols.
Welda	Fine, montmorillonitic, mesic	Typic Hapludalfs	Alfisols.

[1] Placement of some soil series in the current system, particularly the placement in the families, may change as more precise information becomes available. Soils were placed in the classification system according to the Supplement to the 7th Approximation, as amended on July 25, 1968.

[2] In Shawnee County these soils are not dry as much of the time during most years as the classification indicates. They resemble the series in other subgroup characteristics.

[3] In Shawnee County the mean temperatures of these soils are lower than 59° F. They resemble the series in other family characteristics.

supply, farming, transportation and markets, industry and natural resources, and community facilities. The statistics on agriculture and population are from the Census of Agriculture and Kansas State Board of Agriculture crop and livestock report.

History and Development

In 1855 Shawnee County was established by the Territorial County Legislature as one of the original 33 counties. All of the original county was to the south of the Kansas River and included a part of what is now Osage County.

In 1860 the northern boundary of the county was extended to include all the territory that was formerly part of Jackson County south of the second parallel. In 1868 Shawnee County was established within its present boundaries.

Topeka was established as a townsite in 1854. It was named the county seat in 1858 and was designated the State capital in 1861.

Settlement of the county began about 1854. Since that time, the population of the county has increased from 252 in 1855 to 149,788 in 1965. In 1960 the total population in the county was 141,286, of which 21,786 was classed as rural and 119,500 was classed as urban. Since about 1950, communities have grown rapidly, especially in the area around Topeka.

Physiography, Relief, and Drainage

The northern part of Shawnee County is in the Dissected Till Plains section, and the southern part is in the Osage Plains section of the Central Lowlands physiographic province. The major topographic features are the valleys of the Kansas and Wakarusa Rivers that lead to the east and the uplands consisting of low rounded hills with sharp breaks and rock outcrops in some parts near the streams. North of the Kansas River, in the glaciated part of the county, the topography is more subdued than that south of the river, where the bedrock topography formed by the differential erosion of the limestone, shale, and sandstone.

The Kansas River and its tributaries drain the northern three-fourths of the county, and the Wakarusa River drains the southern one-fourth. The uplands form about 78 percent of the acreage in the county, and the bottom lands, about 22 percent.

The lowest points in the county, at elevations of about 835 feet above sea level, are where the Kansas and Wakarusa Rivers leave the county. The highest points are where elevation is about 1,260 feet in the southwestern part of the county. This is a difference in relief of 425 feet.

Climate [9]

Shawnee County, which is near the geographic center of the United States at an elevation of about 1,000 feet, has a typical continental climate. Characteristic of this climate are warm to hot summers, cold winters, moderate surface winds, maximum precipitation in the warm season, and frequent changes in the weather from day to day.

Data on climate, as recorded by the U.S. Weather Bureau at Topeka, are summarized in tables 9, 10, and 11. These data were based on records from 1878 to 1966.

The Gulf of Mexico is the principal source of moisture for the precipitation that falls in Shawnee County. The average yearly precipitation in the county is about 33 inches. An average of about 70 percent of the annual rainfall falls during the growing season, April through September, and only 30 percent falls during the rest of the year. This distribution is beneficial to farming. Winters are dry; only 10 percent of the annual rainfall comes during the period December through February.

TABLE 9.—*Frequency of specified amounts of rainfall during stated time intervals for the central part of Shawnee County*

Length of return period in years [1]	30 min.	1 hr.	2 hrs.	3 hrs.	6 hrs.	12 hrs.	24 hrs.
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1	1. 1	1. 4	1. 7	1. 8	2. 1	2. 4	2. 8
2	1. 4	1. 7	2. 1	2. 2	2. 6	3. 0	3. 5
5	1. 8	2. 2	2. 6	2. 9	3. 4	3. 9	4. 5
10	2. 1	2. 6	3. 1	3. 3	3. 9	4. 6	5. 3
25	2. 4	3. 0	3. 5	3. 9	4. 3	5. 3	6. 1
50	2. 7	3. 4	4. 0	4. 4	5. 2	6. 1	6. 8
100	3. 0	3. 8	4. 5	4. 9	5. 8	6. 8	7. 8

[1] Expresses the frequency of the specified number of inches of rainfall at given time intervals. For example, 2.6 inches of rain can be expected to fall in 2 hours once in every 5 years, and 2.1 inches can be expected in 30 minutes once in 10 years.

Rainfall is less in July than it is in other months in summer. It generally is heaviest in June, though there is a secondary peak in August. Average rainfall is more than 4 inches in May, in June, and in August. Much of the precipitation in the warm season occurs as showers and thundershowers at night or early in the morning. These showers usually do not last long. Heavy downpours occur at times and may cause severe erosion in cultivated fields (*5*). At Topeka the heaviest rainfall in 24 hours occurred in September 1909 and amounted to 8.08 inches.

Figure 15 compares annual precipitation with the precipitation that falls during the growing season. Although precipitation is generally adequate for crops, it varies from year to year. From 1878 to 1966, the annual precipitation ranged from 19.07 inches in 1963 to 48.60 inches in 1951. Figure 15 shows that a very wet year commonly follows a very dry year, or conversely.

[9] By MERLE J. BROWN, State climatologist, U.S. Weather Bureau.

Dry weather that lasts for several months is common in Shawnee County, and longer periods of droughts may occur at irregular intervals. The drought from 1952 to 1957 was especially severe in the county. Serious droughts have also occurred intermittently from 1934 through 1940.

Figure 16 gives probability, in percent, of receiving specified amounts of precipitation in each week of the year. The normal weekly (smoothed) precipitation is also included in the figure. These data are for Horton in Brown County (*3*), which has a climate similar to that of Shawnee County. The probability of receiving significant moisture (0.20 inch or more in a week) is greatest late in May, early in June, and early in August. The probability of significant rainfall in summer is least during the latter part of July.

Table 9 gives the frequencies of various amounts of rainfall for intervals of one-half hour to 24 hours and for return periods of 1 year, 2 years, 5 years, 10 years, 25 years, 50 years, and 100 years.

Shawnee County usually has light snowfalls that average about 20 inches per year. Snowfalls have totaled as much as 44 inches in a winter at Topeka, but a snowfall of more than 30 inches is unusual. In the early part of 1960, snow covered the ground for 35 consecutive days, but this is one of the longest periods on record. Some moderate to heavy snows occasionally occur as late as the early part of April, but snow in spring usually melts rapidly.

The annual range in temperature in Shawnee County is fairly wide because at times heat is intense in summer, and arctic air occasionally surges into the county in winter. The seasonal changes from cold to warm and from warm to cold occur rather rapidly. The average temperature in March is 42.5° and in April is 55°. Even greater is the change from 58° in October to 43.5° in November. In spring and fall, fair days are intermingled with short periods of stormy weather. Outbreaks of stormy weather may last well into spring.

Table 10 gives the average daily maximum temperature, by month, and also contains information on the probability of occurrence of very high or very low temperatures. For example, in January in 2 years out of 10, at least 4 days will have a minimum temperature equal to or lower than 1°. At the other extreme, 2 years out of 10, on the average, will have at least 4 days in July with a maximum temperature of 105° or higher.

Average amounts of monthly and annual precipitation and probabilities for the occurrence of light and heavy monthly and yearly totals of precipitation are also given in table 10. In 1 year out of every 10, on the average, each month from November through January has precipitation totalling less than one-fourth inch. Similarly, precipitation in the month of June will be more than 8½ inches in 1 year out of 10.

Figure 17 shows the means and extremes of temperature at Topeka for the period 1888–1965. At Topeka extremes in temperature have ranged from 25° below zero to 114°. In July and August, the hottest months of record, the mean daily maximum was nearly 90°. An average of 29 days during a year had a temperature of 90° or higher, and 129 days in a year had a minimum temperature of 32° or lower.

TABLE 10.—*Temperature and precipitation at Topeka*

Month	Temperature				Precipitation		
	Average daily maximum [1]	Average daily minimum [1]	Two years in 10 will have at least 4 days with—		Average total [3]	One year in 10 will have—	
			Maximum temperature equal to or higher than [2]—	Minimum temperature equal to or lower than [2]—		Monthly totals less than [3]—	Monthly totals more than [3]—
	°F.	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*
January	38.4	19.2	59	1	0.97	0.10	2.30
February	42.7	22.3	63	7	1.31	.35	2.50
March	53.6	31.6	76	15	2.04	.59	4.22
April	66.1	43.7	83	30	2.96	1.31	5.14
May	75.3	53.8	90	42	4.36	1.92	7.05
June	84.7	63.5	99	54	4.69	1.83	8.67
July	90.1	68.1	105	60	3.91	.98	7.55
August	88.7	66.5	103	59	4.14	.88	7.70
September	80.8	58.0	99	44	3.50	.89	6.30
October	69.8	46.3	87	33	2.39	.53	4.37
November	54.2	33.1	72	17	1.59	.18	3.11
December	42.1	23.5	62	7	1.11	.21	2.16
Year	65.5	44.1	[4] 103	[5] −7	32.97	[6] 24.51	[7] 43.50

[1] Period 1888 through 1966.
[2] Period 1935 through 1960.
[3] Period 1878 through 1966.
[4] Average annual highest maximum temperature for period 1888 through 1965.
[5] Average annual lowest minimum temperature for period 1888 through 1965.
[6] Yearly amount equal to or less than 24.51 inches.
[7] Yearly amount equal to or more than 43.50 inches.

TABLE 11.—*Probabilities of last freezing temperatures in spring and first in fall for the central part of Shawnee County* (*2*)

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	March 27	April 4	April 10	April 20	May 3
2 years in 10 later than	March 21	March 29	April 5	April 15	April 28
5 years in 10 later than	March 9	March 19	March 27	April 5	April 18
Fall:					
1 year in 10 earlier than	November 10	November 5	October 24	October 13	October 7
2 years in 10 earlier than	November 16	November 10	October 28	October 18	October 11
5 years in 10 earlier than	November 28	November 21	November 7	October 27	October 21

The freeze-free period in Shawnee County averages 180 to 185 days in a year (*2*), or about 1 month longer than in the northwestern corner of the State. At Topeka September 27, 1942 was the earliest date in fall for a temperature of 32° and May 19, 1888, was the latest date in spring for that temperature. Crops grown in the area are usually not severely damaged, but truck, garden, and orchard crops are likely to be damaged late in spring in some years. Growth of corn is sometimes reduced by freezes early in fall.

The probabilities for the last freeze in spring and the first in fall are given in table 11. These data indicate that on an average of half of the years the last freezing temperature in spring occurs after April 18. In about half of the years in fall, the first freezing temperature occurs before October 21.

Some of the thundershowers are accompanied by heavy rain, large hailstones, and strong winds. Hail can heavily damage growing crops, though damaging hail is not so frequent in the county as it is in the western part of Kansas. The hailstones are usually small and range from the size of peas to the size of walnuts. Occasionally, however, hailstones ranging from the size of golf balls to the size of baseballs are observed. The hailstorms are generally local, do not last long, and cause damage that varies in severity.

Surface winds are generally light to moderate in all seasons, but strong, blustery winds do occur at times,

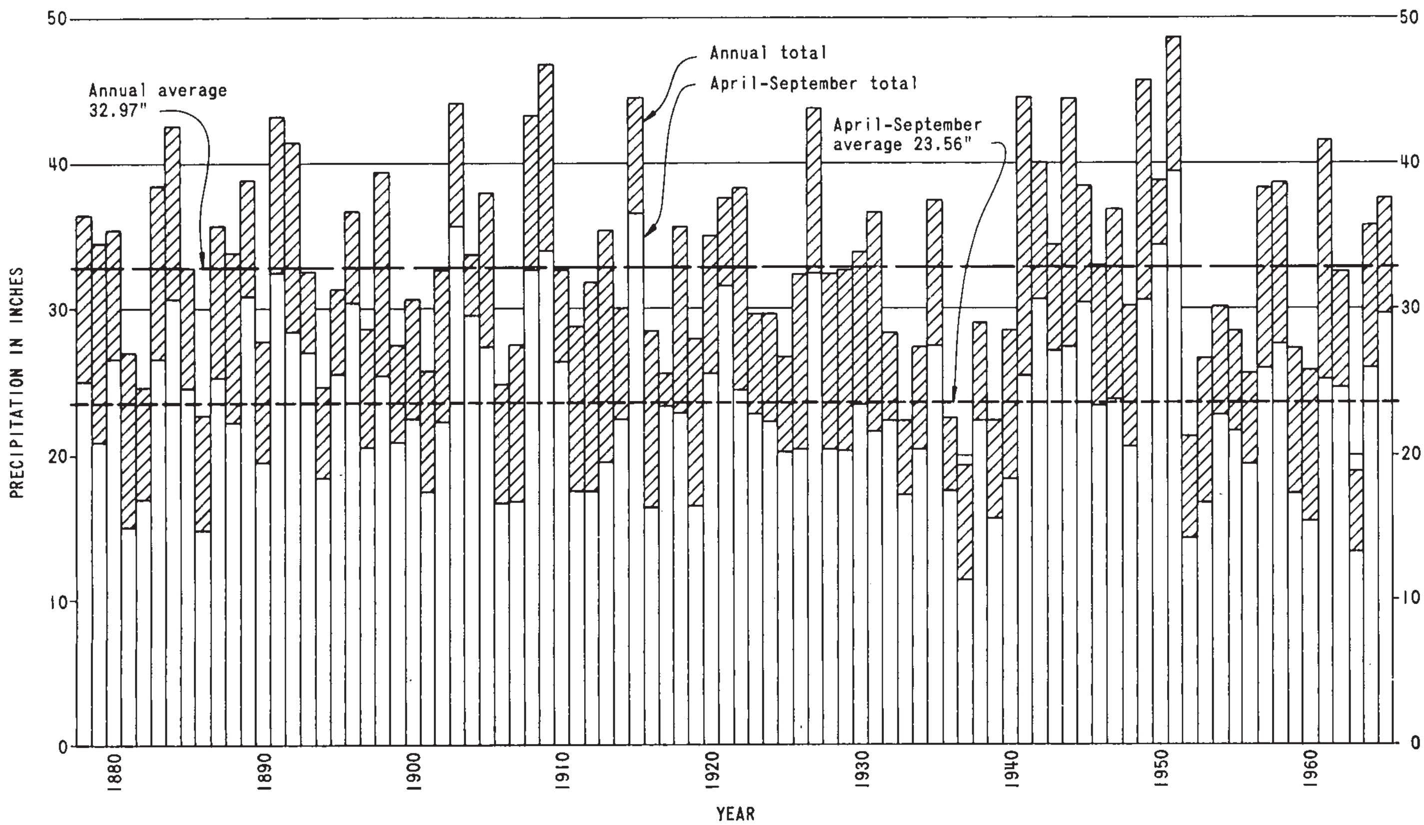

Figure 15.—**Average annual precipitation for the period 1878 through 1965. The solid white part of the bars represents precipitation from March through September. The solid white part and the striped part represent the total annual precipitation.**

particularly late in winter and in spring. The strongest winds average about 13.5 miles per hour and occur in March and April. The prevailing winds are easterly in March, northerly in January and February, and southerly the rest of the year.

The potential evapotranspiration is less in Shawnee County than it is in the western part of the State because the county has higher humidity, lighter winds, more cloudiness, and lower daytime temperatures. Consequently, crops in the county do not lack moisture as frequently as do crops in western Kansas.

Tornadoes occur occasionally and sometimes extensively damage cities and farms in the county. Tornadoes are most frequent in spring and early in summer.

Except when there is not enough rain during the growing season, the climate in Shawnee County is generally favorable for good growth of crops. Crop growth is aided by the amount of solar radiation, favorable temperatures during the growing season, and the good distribution of precipitation.

Water Supply

Water for domestic use on farms in the western half of the county is obtained mostly from dug or drilled wells. In the eastern part of the county, many rural residents are now served by rural water districts that pump water from wells in the valley of the Kansas River or from reservoirs.

Some water for livestock on range or pasture is obtained from wells, but most of it is supplied by farm ponds built on intermittent streams. Wells are the main source of water for livestock around farmsteads and feedlots.

There is no shortage of ground water for domestic use, for watering livestock, or for irrigating fields in the valley of the Kansas River. Irrigation wells in the deeper alluvium in the valley are generally 60 to 80 feet deep, and 800 or more gallons per minute can be pumped from these wells. Wells in the alluvium along the Wakarusa River and the tributary streams of the Kansas River do not produce enough water for irrigation. The wells in the uplands are much less dependable than those in alluvium, because many of these wells fail during extended dry periods. Then it is necessary to haul water for livestock and domestic use. Depth to water in most uplands in the county and the quality and the quantity of water available are usually extremely variable.

Farming

The farming of Shawnee County is based on the growing of cash crops and on raising livestock, mainly beef cattle. In 1835 the first plowing in the county was done on a farm for Indians established by the Federal Government in the valley of Mission Creek. Since that time, cropland harvested in the county has increased to 133,870 acres harvested in 1964 (*6*).

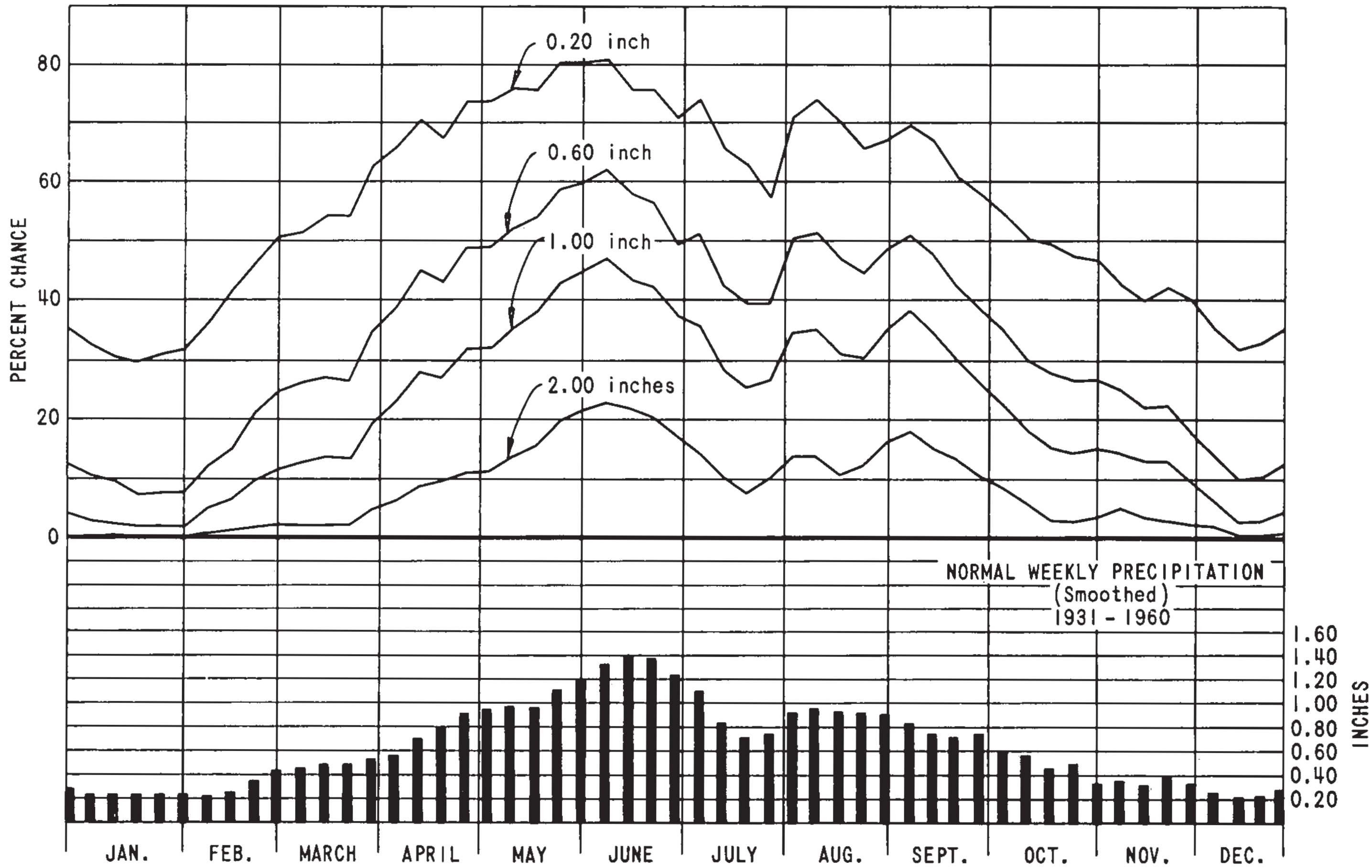

Figure 16.—Top part: **Probability, in percent, of receiving specified amounts of precipitation. *Bottom part:* Normal weekly precipitation (smoothed). Calculated from records at Horton, in Brown County, Kans. Top curves represent periods from 1900–60; bottom bars, 1931–60.**

One of the first commercial irrigation systems was established in Shawnee County in the valley of the Kansas River in 1933. Since about 1953, irrigation systems have been installed on several thousand acres in the valley of the Kansas River. In 1964 about 5,030 acres was irrigated in Shawnee County; corn and alfalfa were the main irrigated field crops. Truck crops and nursery stock are also commonly irrigated.

Crops

Excluding extimates of seed crops, the total cropland harvested in Shawnee County in 1964 was 133,870 acres (*6*). In that year, 35,500 acres of corn was harvested; 19,100 acres of grain sorghum; 36,000 acres of wheat; 4,900 acres of oats; 12,600 acres of alfalfa hay; 2,000 acres of corn for silage; and 1,600 acres of sorghum for silage. Also grown in the county were small acreages of barley, rye, Irish potatoes, sweetpotatoes, and truck crops.

Livestock

Livestock have always been a major source of income in Shawnee County. In most years receipts from livestock and livestock products exceed the income from cash crops. As of January 1, 1965, the Kansas State Board of Agriculture reported the following numbers of livestock on farms in the county: Milk cows, 3,700; other cattle, 30,300; hogs, 8,700; sheep and lambs, 1,800; and chickens, 40,000.

Industry and Natural Resources

Although farming is a major enterprise in Shawnee County, excellent transportation and other community facilities, along with an abundant supply of good-quality water, have caused many industries to locate along the Kansas River in or near Topeka. Rubber tires for automobiles and heavy equipment, cellophane, railroad freight cars, concrete products, and construction equipment are among the products fabricated in the area near Topeka. Electric power, natural gas, and telephone service are large utilities within the county. General offices and shops for railroads and banks, insurance companies, and investment, wholesale, and retail businesses are other important commercial enterprises.

Most of the State agencies have headquarters at Topeka. Two plants dehydrate alfalfa. Major facilities for storing grain are along the railroads in the county.

Sand, gravel, and limestone are the only natural resources of consequence in Shawnee County. Sand and gravel pits furnish material used mainly in making con-

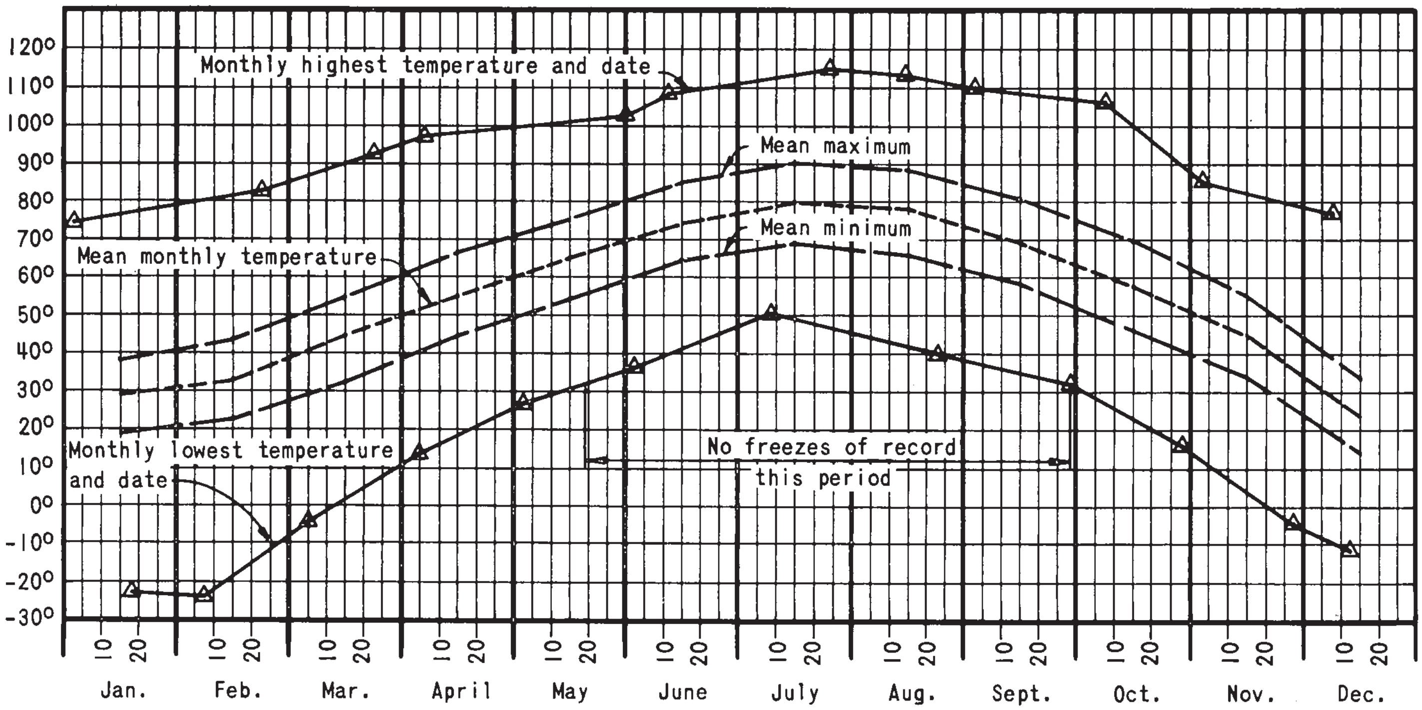

Figure 17.—**Means and extremes of temperature at Topeka.**

crete and for road surfaces. Normally, limestone is crushed for use in concrete, for surfacing roads, and for agricultural lime.

Transportation and Markets

The county is served by 4 major railroads, 31 motor-truck lines, and 4 passenger bus lines. Commercial air-line service is available from Topeka. The county is crossed by Interstate Highway No. 70 and the Kansas Turnpike, which are 4-lane limited access highways. U.S. Highways Nos. 24, 40, and 75 and Kansas Highways Nos. 4 and 10 also pass through the county. In addition, the county has a good system of hard surfaced farm-to-market roads.

Markets for all farm products are readily available. Most wheat and grain that are not fed to animals on the farm are sold to elevators and other storage facilities within the county. Some livestock is sold locally, but most livestock is trucked to markets in Kansas City and St. Joseph, Missouri. Nearly all vegetable and melon crops are marketed in Topeka. Much of the nursery stock is sold locally; sometimes a better market is found outside the county. Poultry, eggs, and milk are generally sold locally in Topeka.

Community Facilities

All rural areas in Shawnee County are included in unified elementary and high school districts. Washburn University, a 4-year accredited college, is in Topeka.

More than 160 churches of various denominations occur throughout the county. Telephone service and electricity are available to all residents in the county.

All hospital facilities for the county are in the city of Topeka. The Topeka-Shawnee County Health Department there offers facilities for public health and nursing service.

For recreation within the county, the public can enjoy facilities for boating, fishing, swimming, and picnicking. Also open to the public are baseball and softball diamonds in several communities in the county. At Topeka golf courses, tennis courts, and bowling alleys are available. Gage Park in Topeka has a large zoo and a beautiful rose garden.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: Clay coat, clay skin.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Clayey soils. As used in this survey, soils that contain more than 35 percent clay.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a wire when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Very friable.—When moist, soil material crushes under very gentle pressure and coheres when pressed together.

Very firm.—Soil material crushes under strong pressure; barely crushable between thumb and forefinger.

Slightly hard.—When dry, soil material is weakly resistant to pressure; easily broken between thumb and forefinger.

Very hard.—When dry, soil material is very resistant to pressure; can be broken in the hands only with difficulty; not breakable between thumb and forefinger.

Extremely hard.—When dry, extremely resistant to pressure; cannot be broken in the hands.

Gravelly soil. A soil that contains a high proportion of rock fragments of gravel size, which are rounded or subangular particles less than 3 inches in diameter.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active, and it is therefore marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused by (1) accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon or (4) some combination of 1, 2, and 3. The combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. This layer, commonly called the soil parent material, is presumed to be like that from which the overlying horizons were formed in most soils. If the underlying material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath the A or B horizon.

Loamy soils. As used in this survey, soils that contain 10 to 70 percent sand, 20 to 80 percent silt, and 15 to 35 percent clay.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles, usually transported by wind.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *Very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Poorly graded soil (engineering). A soil material consisting mainly of particles of nearly the same size. There is little difference in size of the particles in poorly graded soil material; therefore, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See Horizon, soil.

Reaction, soil. The degree of acidity or alkalinity of a soil expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. In words the degree of acidity or alkalinity is expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sandy soils. A broad term for soils of the sand and loamy sand classes; soil material with more than 70 percent sand and less than 15 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slickspots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

Soil textural class. A classification based on the relative proportion of soil separates. The principal classes, in increasing order of the content of finer separates, are as follows: Sand, loamy sand, sandy loam, loam, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying parent material.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. The B horizon in soils with distinct profiles; roughly, the part of the profile below plow depth.

Substratum. Any layer beneath the solum, or true soil; the C or R horizon.

Subsurface layer. A transitional soil layer between the surface layer and the subsoil. It is not present in all soils.

Surface layer. A term used in nontechnical soil descriptions for one or more upper layers of soil; includes the A horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soils, about 5 to 8 inches in thickness. Also called *plowed layer*.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also Clay, Sand, and Silt.) The basic textural classes in order of increasing proportions of fine particles are as follows: *Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Variant, soil. A soil having properties believed to be sufficiently different from other known soils to justify a new series name but occurring in so limited a geographic area that creation of a new series is not believed to be justified.

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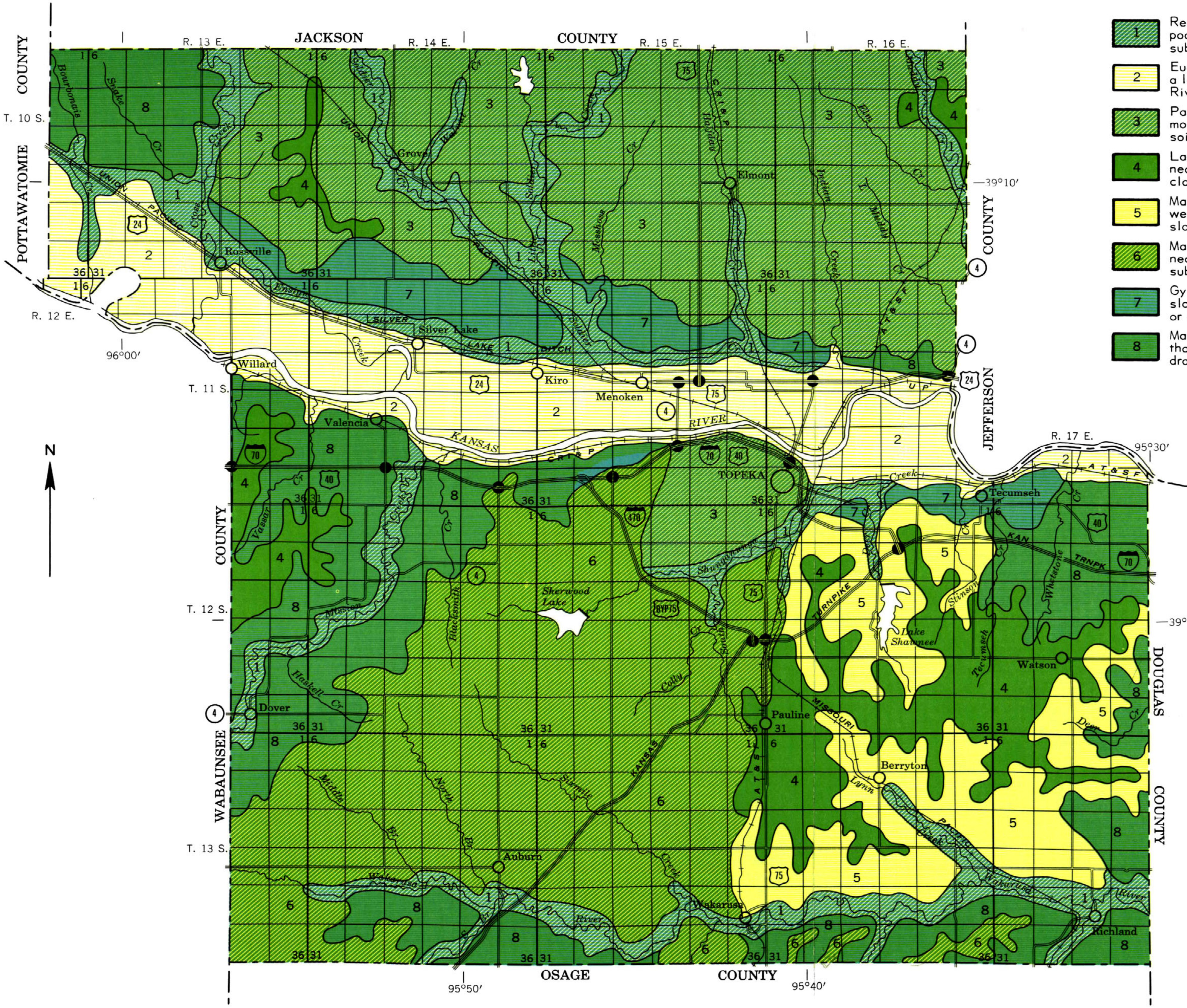


SOIL ASSOCIATIONS

1 Reading-Wabash association: Deep, well-drained to somewhat poorly drained soils that have a silty clay loam or silty clay subsoil; on flood plains and low terraces

2 Eudora-Muir association: Deep, well-drained soils that have a loam to silty clay loam subsoil; on benches in the Kansas River Valley

3 Pawnee-Shelby-Morrill association: Deep, well-drained and moderately well drained, gently sloping to strongly sloping soils that have a clay or clay loam subsoil; on uplands

4 Ladysmith-Pawnee association: Deep, moderately well drained, nearly level and gently sloping soils that have a silty clay or clay subsoil; on uplands

5 Martin-Pawnee-Labetie association: Deep and moderately deep, well-drained and moderately well drained, sloping to strongly sloping soils that have a silty clay or clay subsoil; on uplands

6 Martin-Ladysmith association: Deep, moderately well drained, nearly level to strongly sloping soils that have a silty clay subsoil; on uplands

7 Gymer-Shelby-Sharpsburg association: Deep, well-drained, sloping and strongly sloping soils that have a silty clay loam or clay loam subsoil; on uplands

8 Martin-Sogn association: Deep, moderately well drained soils that have a silty clay subsoil and shallow, somewhat excessively drained soils; on uplands

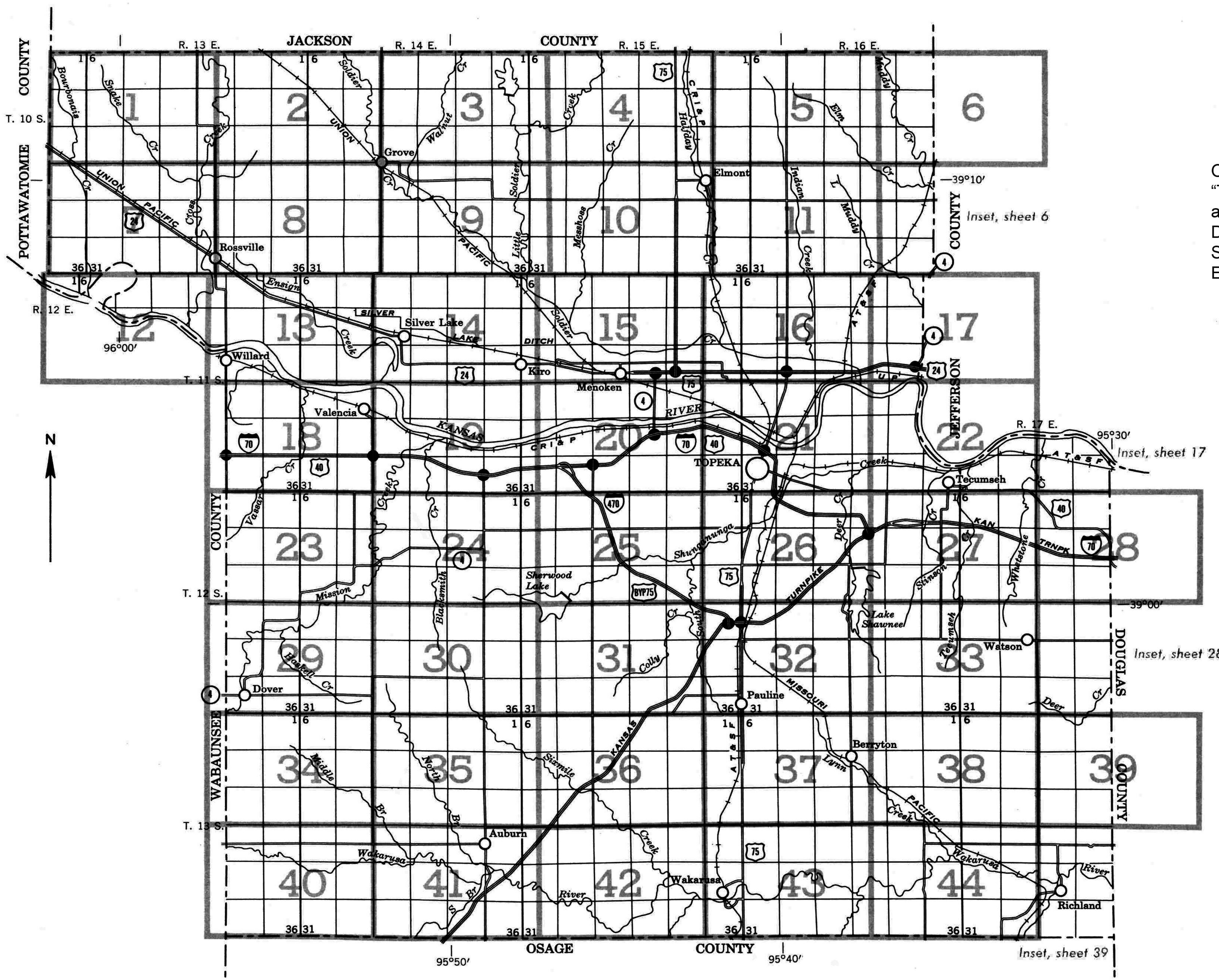
January 1969

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
SHAWNEE COUNTY, KANSAS

Scale 1:190080

1 0 1 2 3 4 Miles



INDEX TO MAP SHEETS
SHAWNEE COUNTY, KANSAS

Scale 1:190080

1 0 1 2 3 4 Miles

Original text from each map sheet:
"This map is one of a set compiled in 1968 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station."

SOIL LEGEND

SYMBOL	NAME
An	Alluvial land
Bk	Breaks–Alluvial land complex
Br	Broken alluvial land
Dm	Dwight–Martin silty clay loams, 1 to 3 percent slopes
Ds	Dwight silty clay loam, 0 to 1 percent slopes
Dw	Dwight silty clay loam, 1 to 3 percent slopes
El	Elmont silt loam, 3 to 7 percent slopes
Em	Elmont silt loam, 3 to 7 percent slopes, eroded
En	Elmont silt loam, 7 to 12 percent slopes
Eo	Elmont silt loam, 7 to 12 percent slopes, eroded
Ep	Elmont–Slickspots complex, 3 to 7 percent slopes, eroded
Es	Eudora sandy loam, sandy variant, 1 to 3 percent slopes
Et	Eudora silt loam
Eu	Eudora soils, 6 to 12 percent slopes, eroded
Ev	Eudora–Kimo complex
Ew	Eudora–Kimo complex, overwash
Gm	Gymer silt loam, 3 to 8 percent slopes
Gy	Gymer silt loam, 3 to 8 percent slopes, eroded
Kb	Kennebec silt loam
Kc	Kennebec silt loam, clayey substratum
Km	Kimo silty clay loam
Ko	Kimo soils, depressional
Ks	Kipson–Sogn complex
Ku	Konawa fine sandy loam, 4 to 8 percent slopes
Kw	Konawa fine sandy loam, 8 to 12 percent slopes
La	Labette silty clay loam, 1 to 3 percent slopes
Lb	Labette silty clay loam, 3 to 6 percent slopes
Lc	Labette silty clay loam, 3 to 6 percent slopes, eroded
Ld	Ladysmith silty clay loam, 0 to 1 percent slopes
Lm	Ladysmith silty clay loam, 1 to 3 percent slopes
Ls	Ladysmith silty clay loam, 1 to 3 percent slopes, eroded
Ma	Made land
Mb	Martin silty clay loam, 1 to 3 percent slopes
Mc	Martin silty clay loam, 3 to 7 percent slopes
Me	Martin silty clay loam, 3 to 7 percent slopes, eroded
Mf	Martin silty clay loam, 7 to 11 percent slopes
Mh	Martin silty clay loam, 7 to 11 percent slopes, eroded
Mk	Martin soils, 3 to 7 percent slopes, severely eroded
Mm	Morrill clay loam, 3 to 8 percent slopes
Mn	Morrill clay loam, 3 to 8 percent slopes, eroded
Mo	Morrill clay loam, 8 to 12 percent slopes
Mp	Morrill–Gravelly land complex, 4 to 12 percent slopes
Mr	Muir silt loam
Pa	Pawnee clay loam, 0 to 3 percent slopes
Pc	Pawnee clay loam, 3 to 7 percent slopes
Pe	Pawnee clay loam, 3 to 7 percent slopes, eroded
Pn	Pawnee clay loam, 7 to 11 percent slopes
Re	Reading silty clay loam, 0 to 2 percent slopes
Rv	Riverwash
Sa	Sarpy sand
Se	Sarpy–Eudora complex, overwash
Sg	Sharpsburg silty clay loam, 1 to 3 percent slopes
Sh	Sharpsburg silty clay loam, 3 to 6 percent slopes
Sk	Shelby clay loam, 1 to 3 percent slopes
Sm	Shelby clay loam, 3 to 8 percent slopes
Sn	Shelby clay loam, 3 to 8 percent slopes, eroded
So	Shelby clay loam, 8 to 12 percent slopes
Sp	Shellabarger fine sandy loam, 3 to 8 percent slopes
Sr	Shellabarger fine sandy loam, 3 to 8 percent slopes, eroded
Ss	Shellabarger fine sandy loam, 8 to 12 percent slopes
St	Sibleyville loam, 3 to 7 percent slopes
Su	Sibleyville loam, 7 to 11 percent slopes
Sv	Sogn–Vinland complex
Sw	Stony steep land
Vn	Vinland silty clay loam
Wa	Wabash silty clay
Wb	Wabash silty clay loam
We	Welda silt loam, 4 to 10 percent slopes

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Tunnel

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

BOUNDARIES

- National or state
- County
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches (CANAL)

Lakes and ponds
- Perennial (water, w)
- Intermittent

Spring

Marsh or swamp

Wet spot

Alluvial fan

Drainage end

RELIEF

Escarpments
- Bedrock
- Other

Prominent peak

Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness: Stony; Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Sandy area

Soil map constructed 1968 by Cartographic Division, Soil Conservation Service, USDA, from 1966 aerial photographs. Controlled mosaic based on Kansas plane coordinate system, north zone, Lambert conformal conic projection, 1927 North American datum.

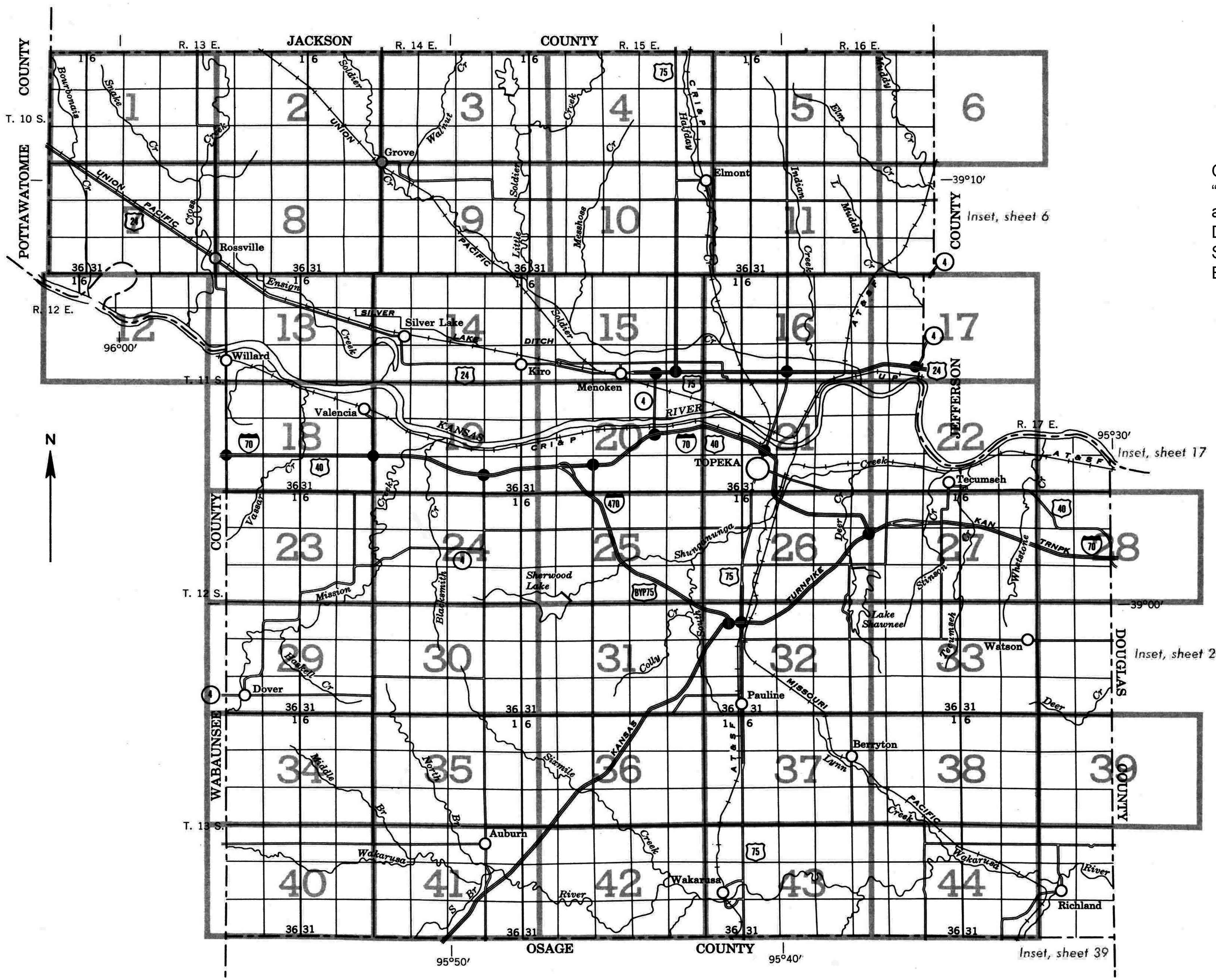
GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Dashes show that the mapping unit is not suited to range or woodland and was not placed in a range site or woodland group. Other information is given in tables as follows:

Acreage and extent, table 1, p. 7.
Average yields, table 2, p. 38.
Potential of soils for wildlife, table 3, p. 45.
Engineering uses of soils, tables 4, 5, and 6, pp. 48 through 63.
Use of soils for recreational sites, table 7, p. 64.

Map symbol	Mapping unit	Page	Capability unit		Range site		Woodland suitability group	
			Symbol	Page	Name	Page	Number	Page
An	Alluvial land	6	VIw-1	36	Loamy Lowland	40	1	42
Bk	Breaks-Alluvial land complex	6						
	Breaks	--	VIe-1	36	Loamy Upland	40	4	43
	Alluvial land	--	VIe-1	36	Loamy Lowland	40	1	42
Br	Broken alluvial land	6	VIIw-1	37	-------------	--	1	42
Dm	Dwight-Martin silty clay loams, 1 to 3 percent slopes	8						
	Dwight soil	--	IVe-6	35	Claypan	39	--	--
	Martin soil	--	IVe-6	35	Loamy Upland	40	4	43
Ds	Dwight silty clay loam, 0 to 1 percent slopes	8	IVs-1	36	Claypan	39	--	--
Dw	Dwight silty clay loam, 1 to 3 percent slopes	8	IVe-6	35	Claypan	39	--	--
El	Elmont silt loam, 3 to 7 percent slopes	9	IIIe-3	33	Loamy Upland	40	4	43
Em	Elmont silt loam, 3 to 7 percent slopes, eroded	9	IIIe-5	34	Loamy Upland	40	4	43
En	Elmont silt loam, 7 to 12 percent slopes	9	IVe-3	35	Loamy Upland	40	4	43
Eo	Elmont silt loam, 7 to 12 percent slopes, eroded	9	VIe-1	36	Loamy Upland	40	4	43
Ep	Elmont-Slickspots complex, 3 to 7 percent slopes, eroded	9						
	Elmont soil	--	VIe-3	36	Loamy Upland	40	4	43
	Slickspots	--	VIe-3	36	Claypan	39	--	--
Es	Eudora sandy loam, sandy variant, 1 to 3 percent slopes	10	IIe-3	31	Sandy Lowland	40	5	43
Et	Eudora silt loam	10	I-1	31	Loamy Lowland	40	6	43
Eu	Eudora soils, 6 to 12 percent slopes, eroded	10	IIIe-1	33	Loamy Lowland	40	6	43
Ev	Eudora-Kimo complex	10						
	Eudora soil	--	IIw-1	33	Loamy Lowland	40	6	43
	Kimo soil	--	IIw-1	33	Clay Lowland	39	2	42
Ew	Eudora-Kimo complex, overwash	10						
	Eudora soil	--	IIw-1	33	Loamy Lowland	40	6	43
	Kimo soil	--	IIw-1	33	Clay Lowland	39	2	42
Gm	Gymer silt loam, 3 to 8 percent slopes	11	IIIe-1	33	Loamy Upland	40	3	42
Gy	Gymer silt loam, 3 to 8 percent slopes, eroded	11	IIIe-6	34	Loamy Upland	40	3	42
Kb	Kennebec silt loam	12	IIw-2	33	Loamy Lowland	40	1	42
Kc	Kennebec silt loam, clayey substratum	12	IIw-2	33	Loamy Lowland	40	1	42
Km	Kimo silty clay loam	13	IIw-1	33	Clay Lowland	39	2	42
Ko	Kimo soils, depressional	13	Vw-1	36	Clay Lowland	39	2	42
Ks	Kipson-Sogn complex	13						
	Kipson soil	--	VIe-2	36	Limy Upland	40	--	--
	Sogn soil	--	VIe-2	36	Shallow	41	--	--
Ku	Konawa fine sandy loam, 4 to 8 percent slopes	14	IIIe-4	34	Savannah	40	8	44
Kw	Konawa fine sandy loam, 8 to 12 percent slopes	14	IVe-4	35	Savannah	40	8	44
La	Labette silty clay loam, 1 to 3 percent slopes	14	IIe-1	31	Loamy Upland	40	4	43
Lb	Labette silty clay loam, 3 to 6 percent slopes	15	IIIe-3	33	Loamy Upland	40	4	43
Lc	Labette silty clay loam, 3 to 6 percent slopes, eroded	15	IIIe-5	34	Loamy Upland	40	4	43
Ld	Ladysmith silty clay loam, 0 to 1 percent slopes	15	IIs-1	32	Clay Upland	39	--	--
Lm	Ladysmith silty clay loam, 1 to 3 percent slopes	15	IIIe-2	33	Clay Upland	39	--	--
Ls	Ladysmith silty clay loam, 1 to 3 percent slopes, eroded	15	IVe-1	34	Claypan	39	--	--
Ma	Made land	16	-------	--	-------------	--	--	--
Mb	Martin silty clay loam, 1 to 3 percent slopes	16	IIe-1	31	Loamy Upland	40	4	43
Mc	Martin silty clay loam, 3 to 7 percent slopes	16	IIIe-3	33	Loamy Upland	40	4	43
Me	Martin silty clay loam, 3 to 7 percent slopes, eroded	17	IIIe-5	34	Clay Upland	39	4	43
Mf	Martin silty clay loam, 7 to 11 percent slopes	17	IVe-3	35	Loamy Upland	40	4	43
Mh	Martin silty clay loam, 7 to 11 percent slopes, eroded	17	VIe-1	36	Clay Upland	39	4	43
Mk	Martin soils, 3 to 7 percent slopes, severely eroded	17	VIe-3	36	Clay Upland	39	4	43
Mm	Morrill clay loam, 3 to 8 percent slopes	18	IIIe-1	33	Loamy Upland	40	3	42
Mn	Morrill clay loam, 3 to 8 percent slopes, eroded	19	IIIe-6	34	Loamy Upland	40	3	42
Mo	Morrill clay loam, 8 to 12 percent slopes	19	IVe-5	35	Loamy Upland	40	3	42
Mp	Morrill-Gravelly land complex, 4 to 12 percent slopes	19	VIe-1	36	Loamy Upland	40	--	--
Mr	Muir silt loam	20	I-1	31	Loamy Lowland	40	6	43
Pa	Pawnee clay loam, 0 to 3 percent slopes	21	IIe-1	31	Loamy Upland	40	4	43
Pc	Pawnee clay loam, 3 to 7 percent slopes	21	IIIe-3	33	Loamy Upland	40	4	43
Pe	Pawnee clay loam, 3 to 7 percent slopes, eroded	21	IIIe-5	34	Clay Upland	39	4	43
Pn	Pawnee clay loam, 7 to 11 percent slopes	21	IVe-3	35	Loamy Upland	40	4	43
Re	Reading silty clay loam, 0 to 2 percent slopes	22	I-1	31	Loamy Lowland	40	6	43
Rv	Riverwash	22	VIIIs-1	37	-------------	--	--	--
Sa	Sarpy sand	22	VIs-1	36	Sandy Lowland	40	5	43
Se	Sarpy-Eudora complex, overwash	22						
	Sarpy soil	--	IIe-3	31	Sandy Lowland	40	5	43
	Eudora soil	--	IIe-3	31	Sandy Lowland	40	6	43
Sg	Sharpsburg silty clay loam, 1 to 3 percent slopes	23	IIe-2	31	Loamy Upland	40	3	42
Sh	Sharpsburg silty clay loam, 3 to 6 percent slopes	23	IIIe-1	33	Loamy Upland	40	3	42
Sk	Shelby clay loam, 1 to 3 percent slopes	24	IIe-2	31	Loamy Upland	40	3	42
Sm	Shelby clay loam, 3 to 8 percent slopes	24	IIIe-1	33	Loamy Upland	40	3	42
Sn	Shelby clay loam, 3 to 8 percent slopes, eroded	24	IIIe-6	34	Loamy Upland	40	3	42
So	Shelby clay loam, 8 to 12 percent slopes	24	IVe-5	35	Loamy Upland	40	3	42
Sp	Shellabarger fine sandy loam, 3 to 8 percent slopes	25	IIIe-4	34	Sandy	40	8	44
Sr	Shellabarger fine sandy loam, 3 to 8 percent slopes, eroded	25	IVe-4	35	Sandy	40	8	44
Ss	Shellabarger fine sandy loam, 8 to 12 percent slopes	25	VIe-1	36	Sandy	40	8	44
St	Sibleyville loam, 3 to 7 percent slopes	26	IVe-2	35	Loamy Upland	40	7	44
Su	Sibleyville loam, 7 to 11 percent slopes	26	VIe-1	36	Loamy Upland	40	7	44
Sv	Sogn-Vinland complex	27						
	Sogn soil	--	VIe-2	36	Shallow	41	--	--
	Vinland soil	--	VIe-2	36	Loamy Upland	40	--	--
Sw	Stony steep land	27	VIIe-1	37	Breaks	39	--	--
Vn	Vinland silty clay loam	27	VIe-1	36	Loamy Upland	40	--	--
Wa	Wabash silty clay	28	IIIw-1	34	Clay Lowland	39	2	42
Wb	Wabash silty clay loam	29	IIw-1	33	Clay Lowland	39	2	42
We	Welda silt loam, 4 to 10 percent slopes	30	IIIe-3	33	Savannah	40	3	42

336-093 O - 70 (Face soil maps)

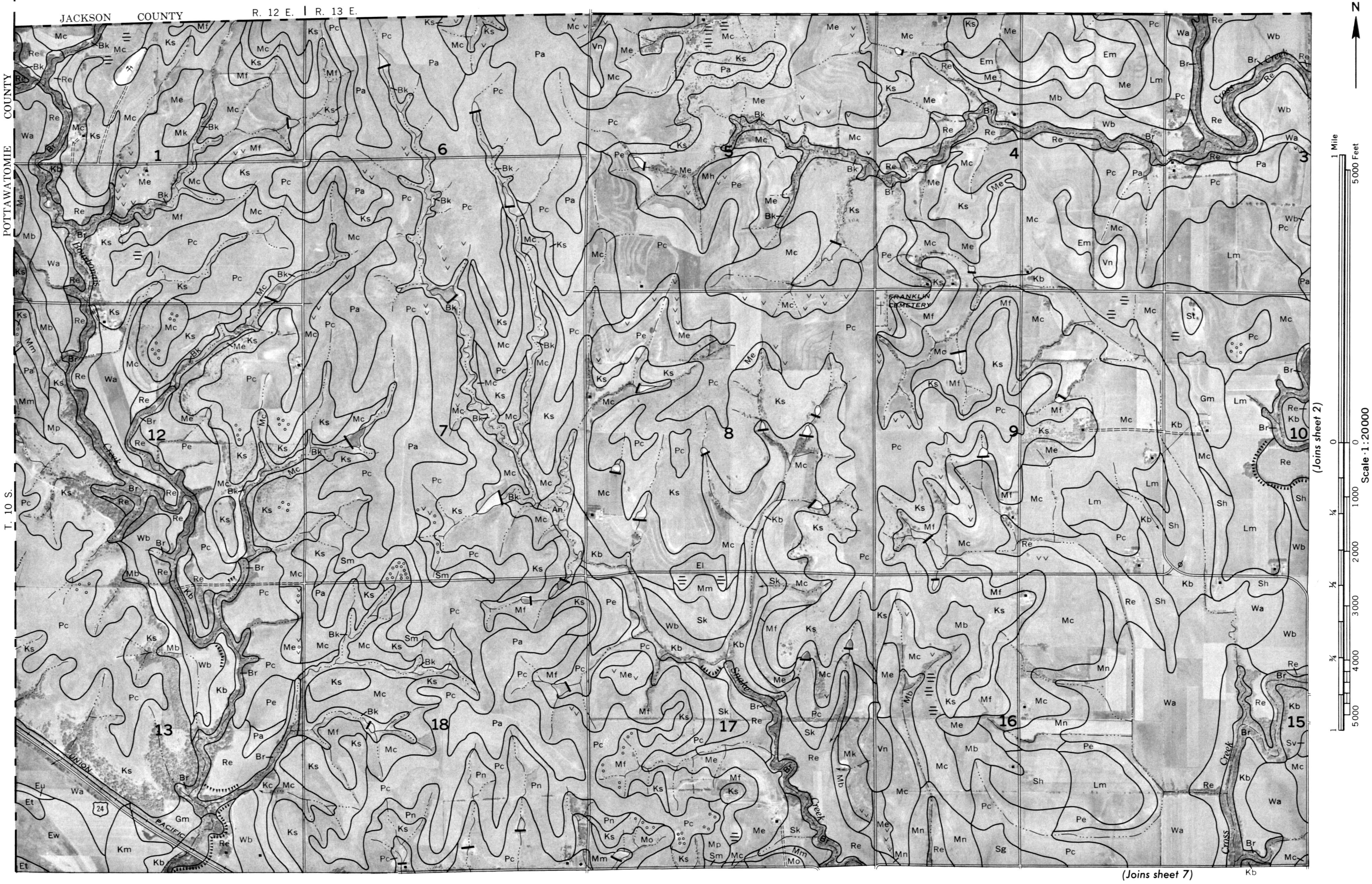


Original text from each map sheet:
"This map is one of a set compiled in 1968 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station."

INDEX TO MAP SHEETS
SHAWNEE COUNTY, KANSAS

Scale 1:190080

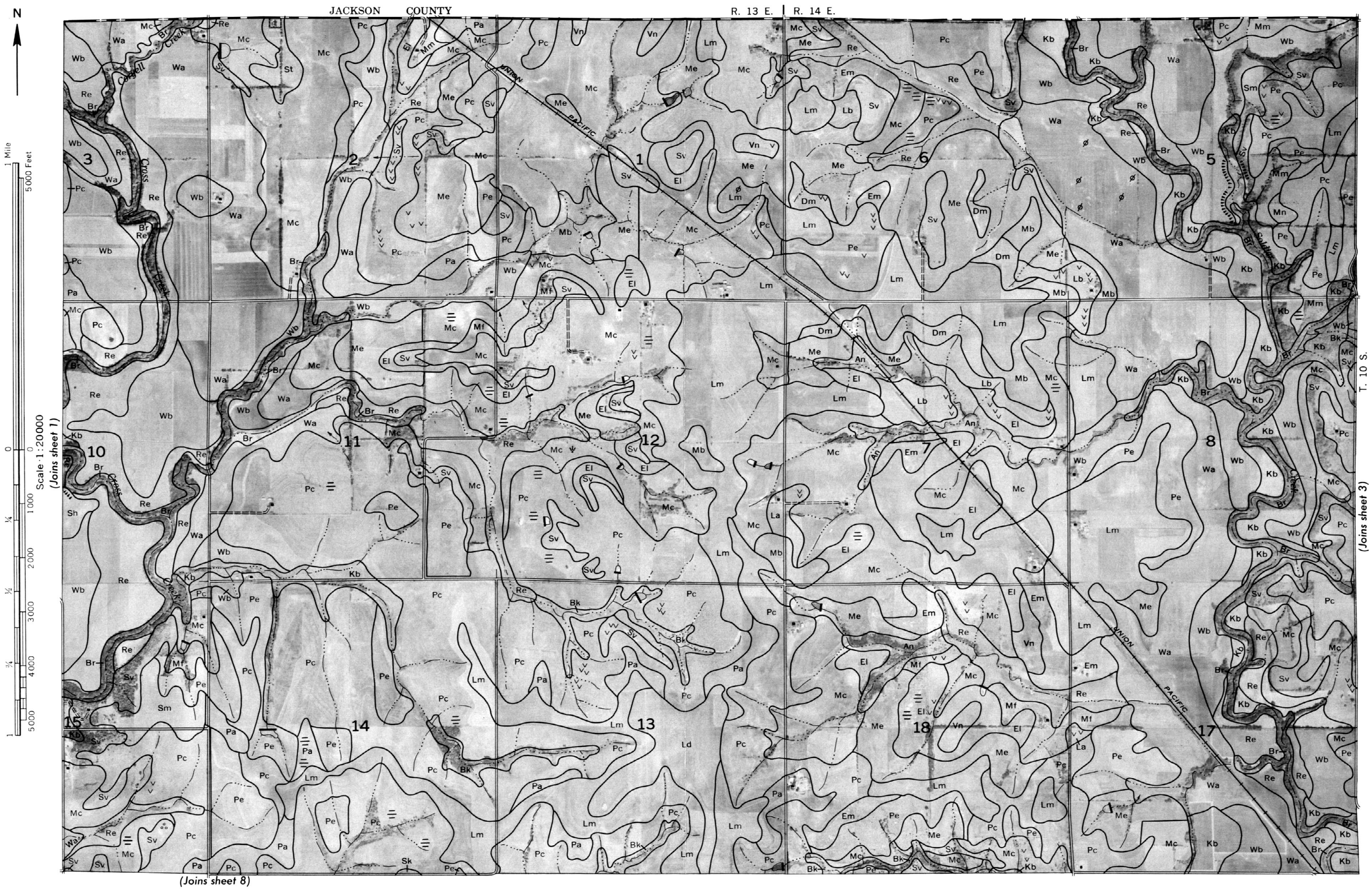
1 0 1 2 3 4 Miles



Land division corners are approximately positioned on this map.

SHAWNEE COUNTY, KANSAS NO. 1

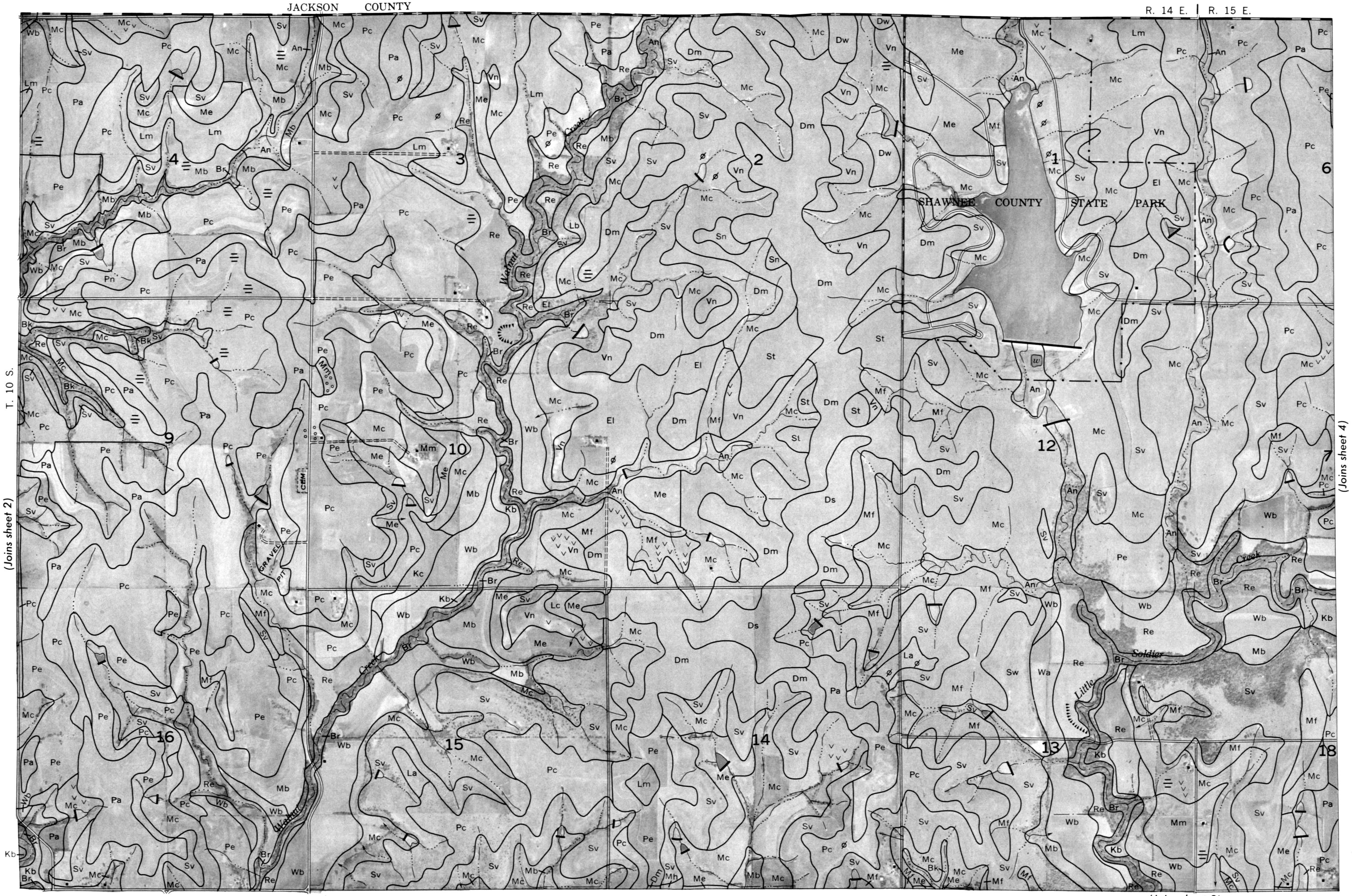
SHAWNEE COUNTY, KANSAS — SHEET NUMBER 2



SHAWNEE COUNTY, KANSAS NO. 2

3

N



(Joins sheet 2)

(Joins sheet 4)

(Joins sheet 9)

Scale 1:20000

1 Mile

5000 Feet

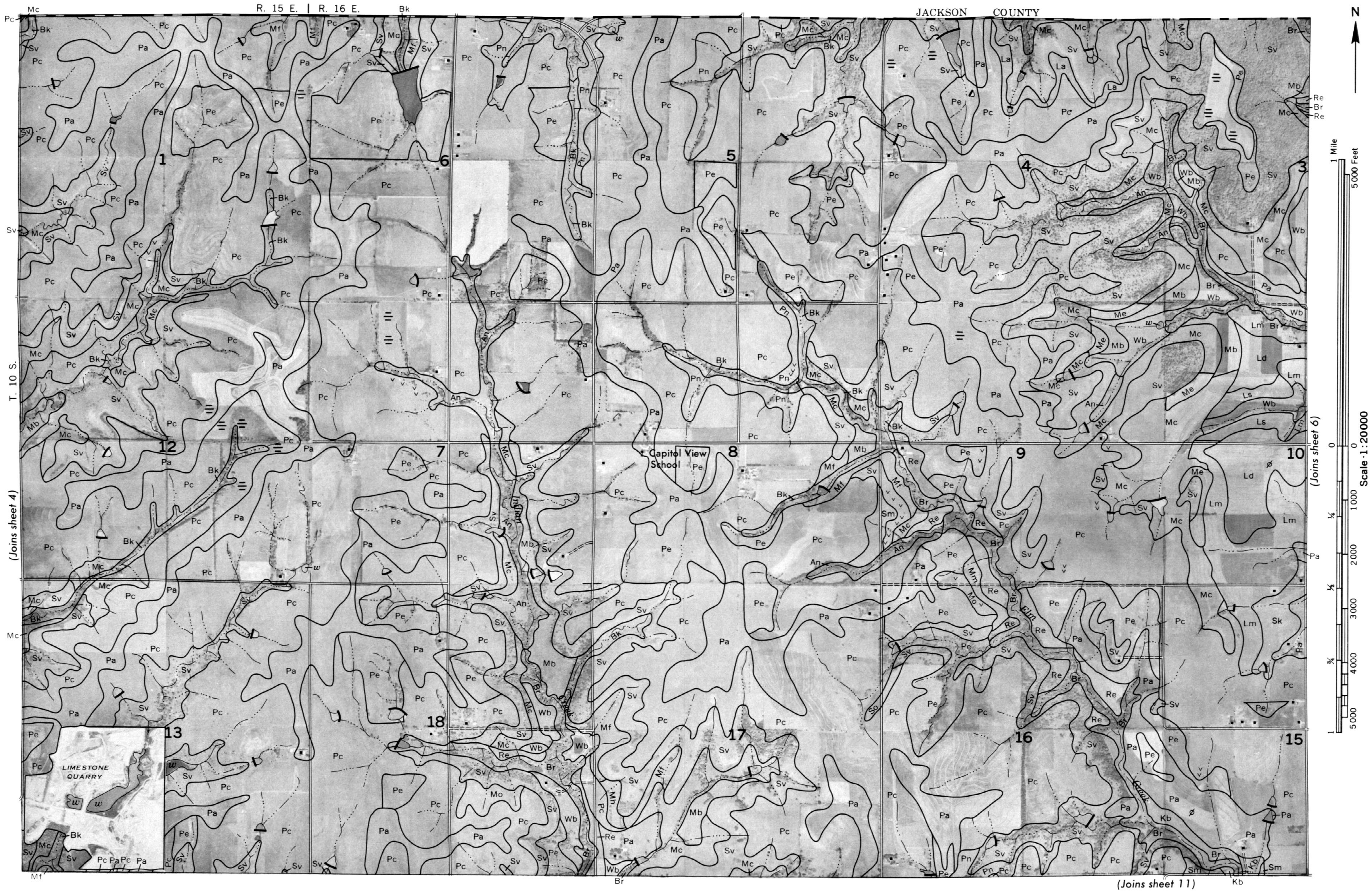
Land division corners are approximately positioned on this map.

SHAWNEE COUNTY, KANSAS NO. 3

4

N

(Joins sheet 10)



Land division corners are approximately positioned on this map.
SHAWNEE COUNTY, KANSAS NO. 5

6

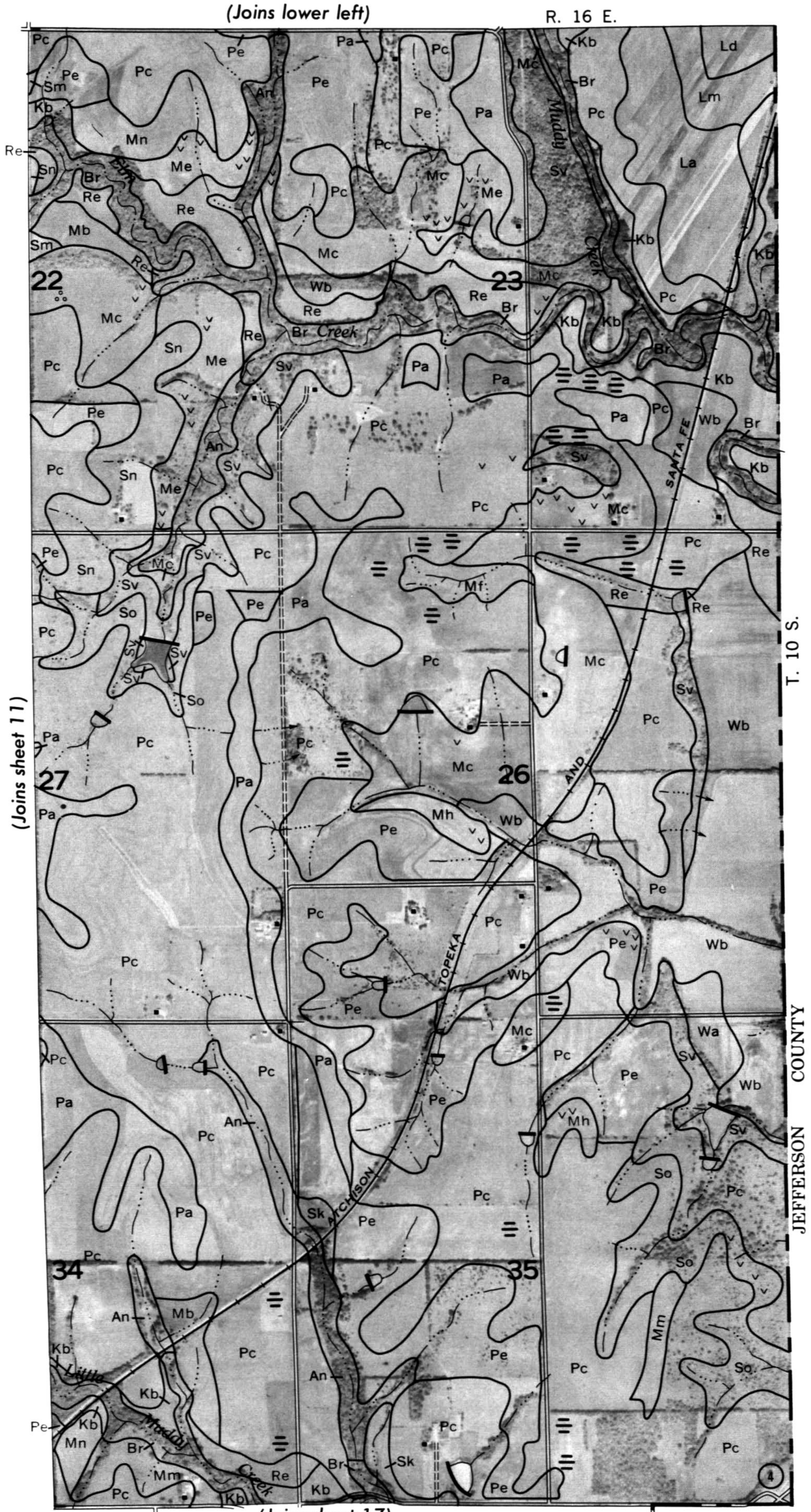
N

1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
Scale 1:20000
(Joins sheet 5)

(Joins upper right)

(Joins lower left)

(Joins sheet 11)



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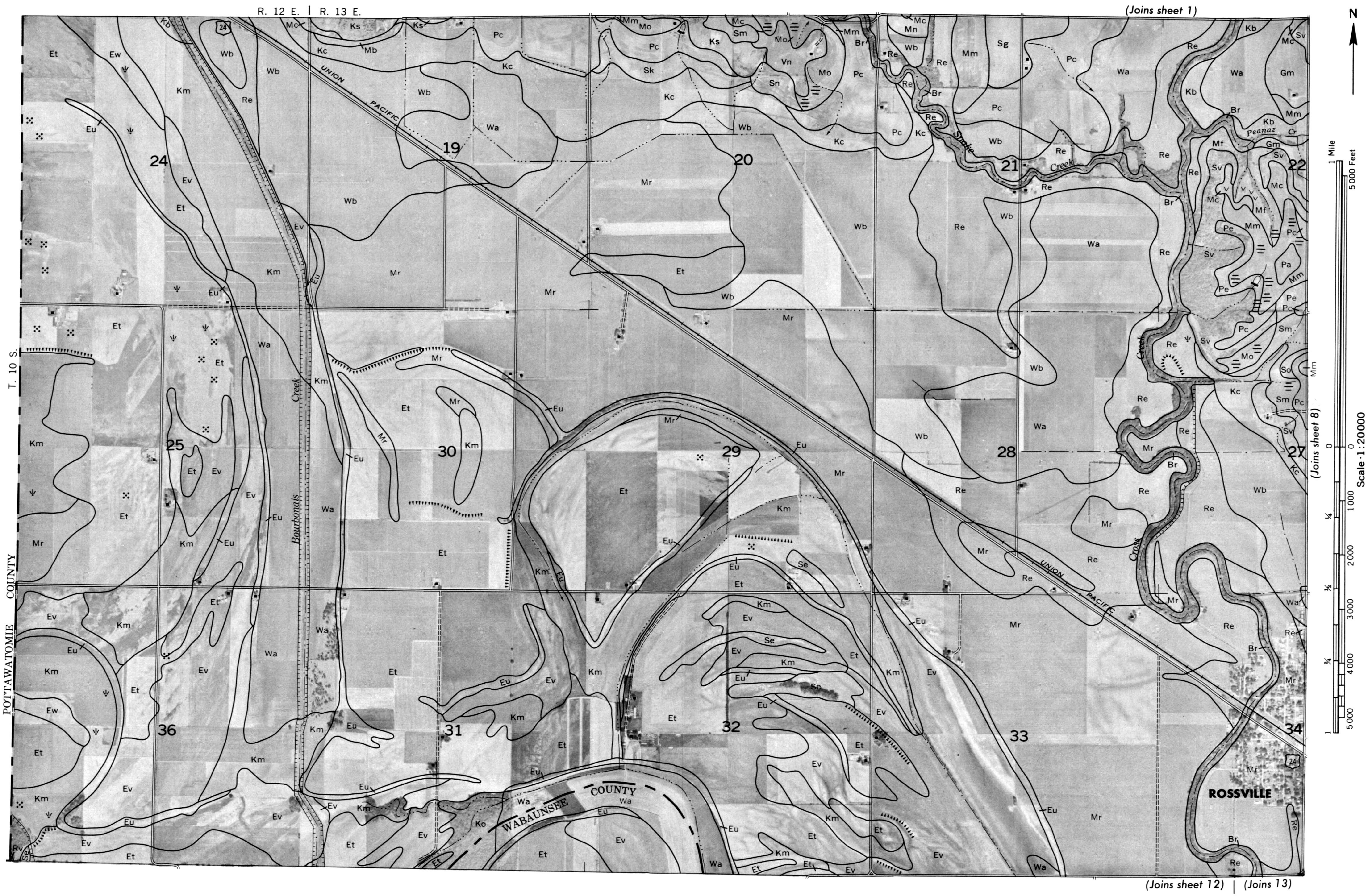

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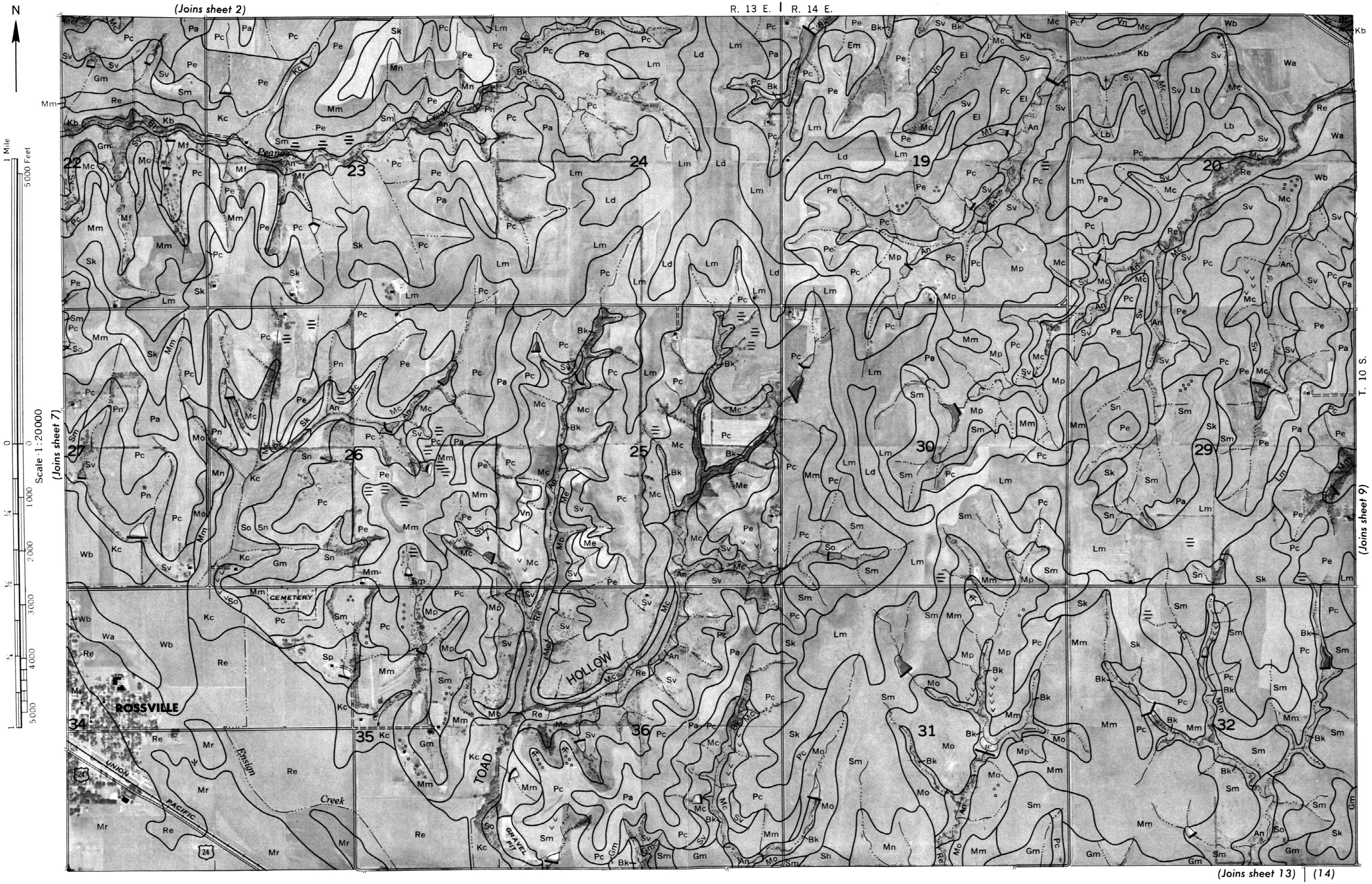
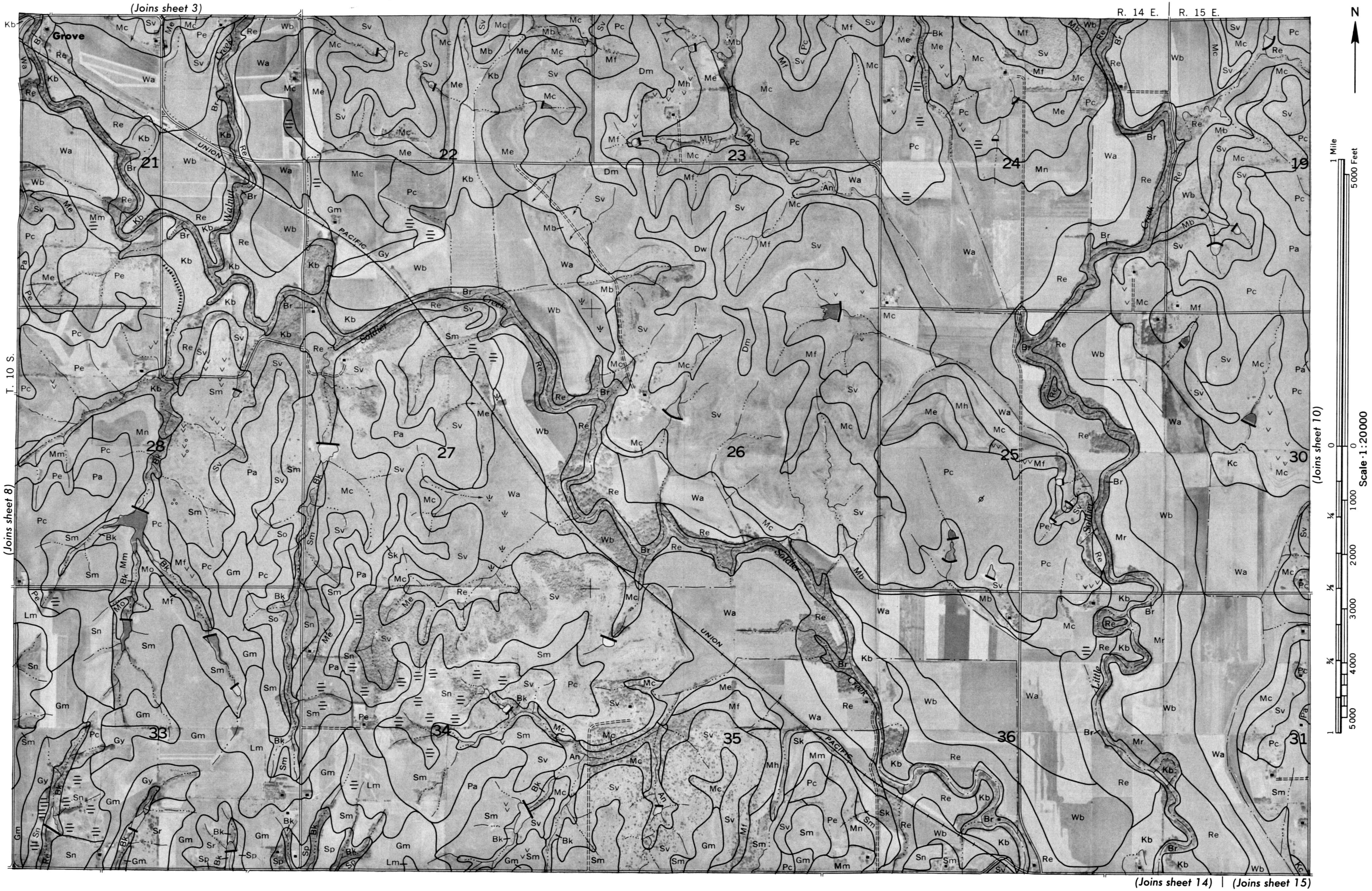
SHAWNEE COUNTY, KANSAS NO. 7

SHAWNEE COUNTY, KANSAS — SHEET NUMBER 8





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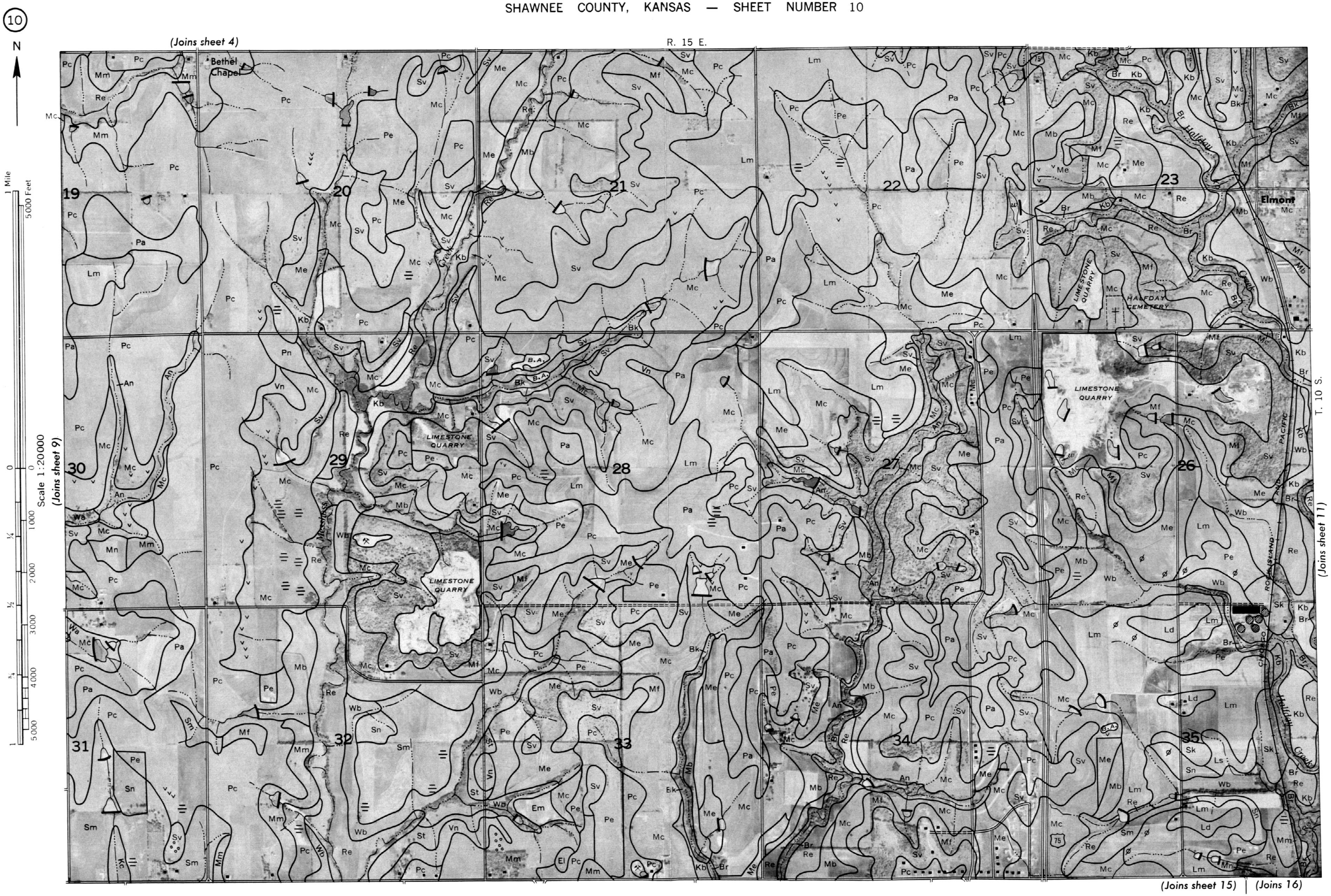
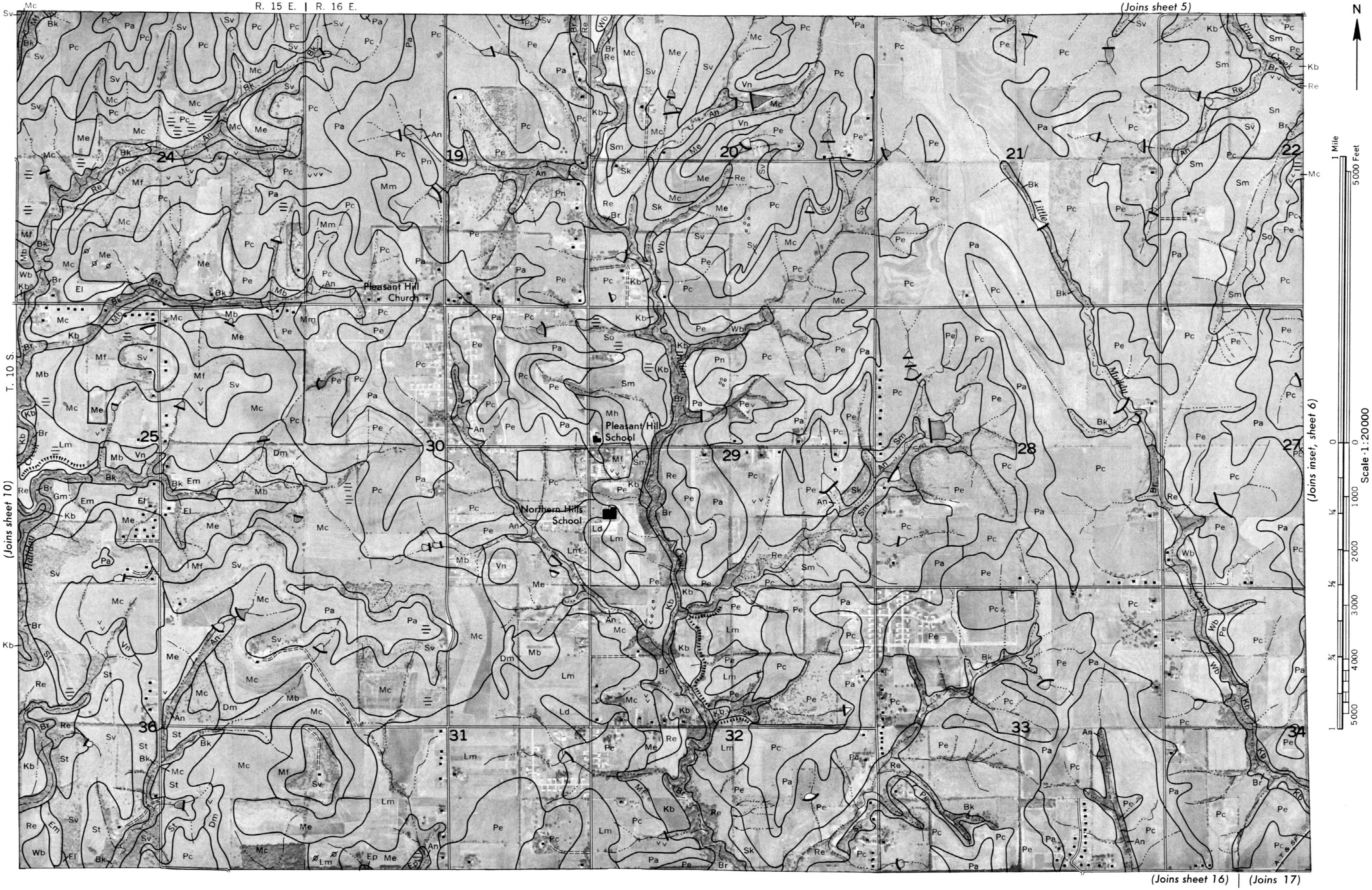
SHAWNEE COUNTY, KANSAS NO. 9

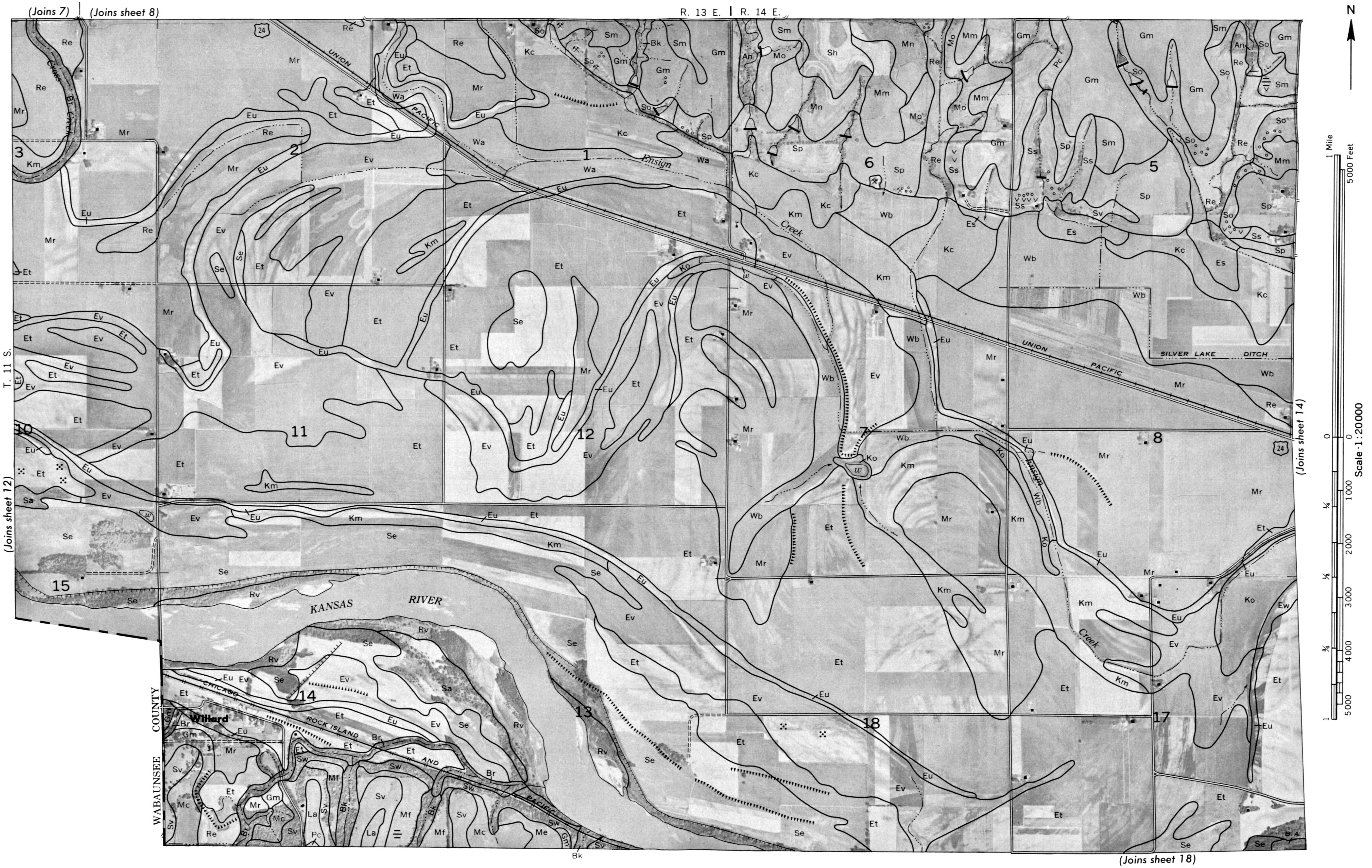

10
N
(Joins sheet 4)
R. 15 E.
T. 10 S.
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 15)
(Joins 16)
Bethel Chapel
Elmont
LIMESTONE QUARRY
HALFDAY CEMETERY
Halfday Creek
ROCK ISLAND
PACIFIC
CHICAGO
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35



Land division corners are approximately positioned on this map.
SHAWNEE COUNTY, KANSAS NO. 11

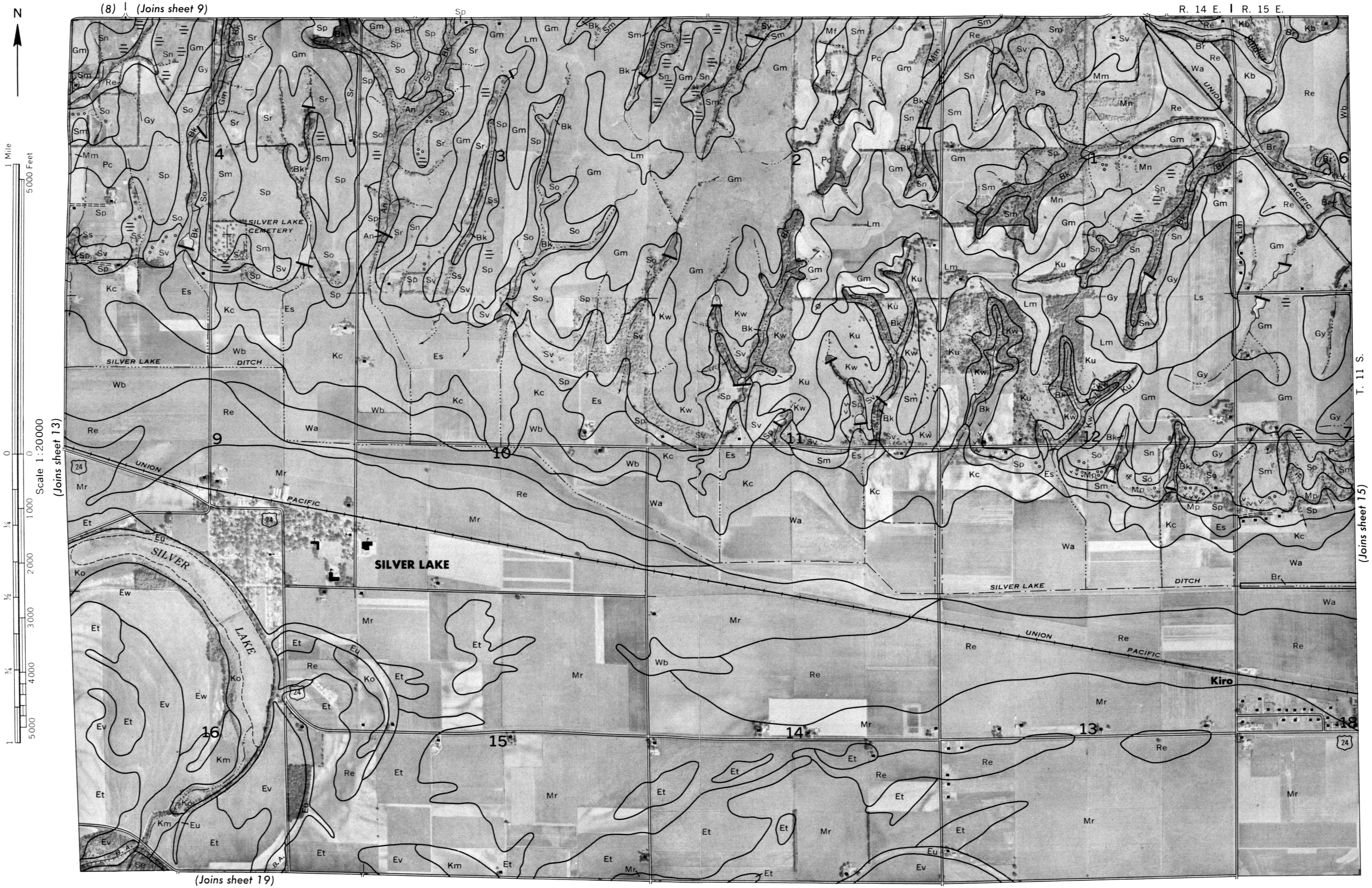
12

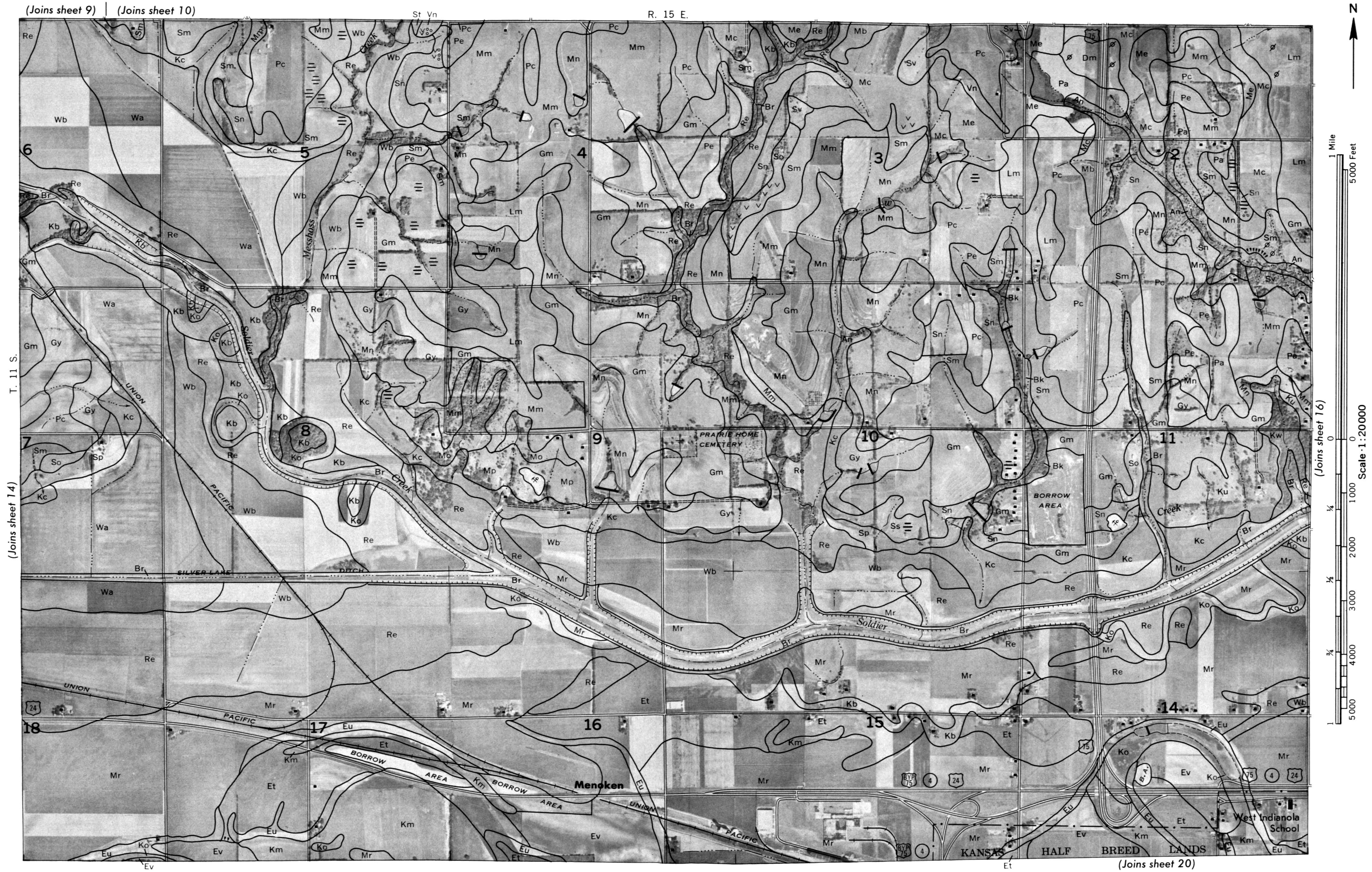

N
(Joins sheet 7)
R. 12 E.
R. 13 E.
T. 11 S.
(Joins sheet 13)
KANSAS RIVER
WABAUNSEE COUNTY
KANSAS RIVER
WABAUNSEE COUNTY
Bourbonais Creek
Cross Creek
1 Mile
5000 Feet
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
Scale 1:20000
Br
Et
Eu
Ev
Km
Ko
Mr
Re
Rv
Sa
Se
Wa
1
4
5
6
7
8
9
10



Land division corners are approximately positioned on this map.

SHAWNEE COUNTY, KANSAS NO. 13


N
(8)
(Joins sheet 9)
R. 14 E.
R. 15 E.
T. 11 S.
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 19)
Scale 1:20000
1 Mile
5000 Feet
SILVER LAKE CEMETERY
SILVER LAKE DITCH
SILVER LAKE
UNION PACIFIC
Kiro
B. A.



Land division corners are approximately positioned on this map.

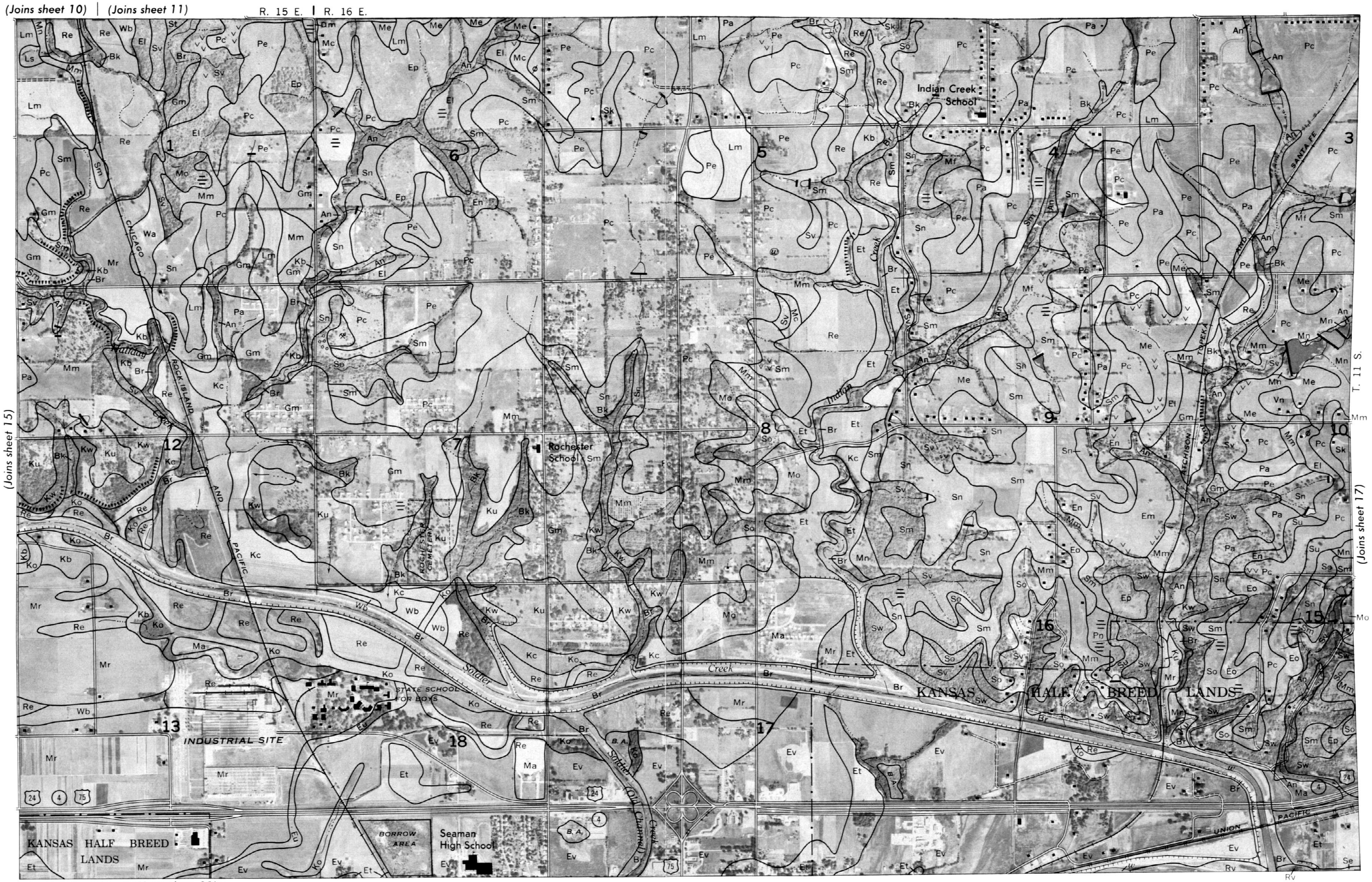
SHAWNEE COUNTY, KANSAS NO. 15

SHAWNEE COUNTY, KANSAS — SHEET NUMBER 16

N

(Joins sheet 10) | (Joins sheet 11)

R. 15 E. | R. 16 E.



1 Mile | 5000 Feet

Scale 1:20000

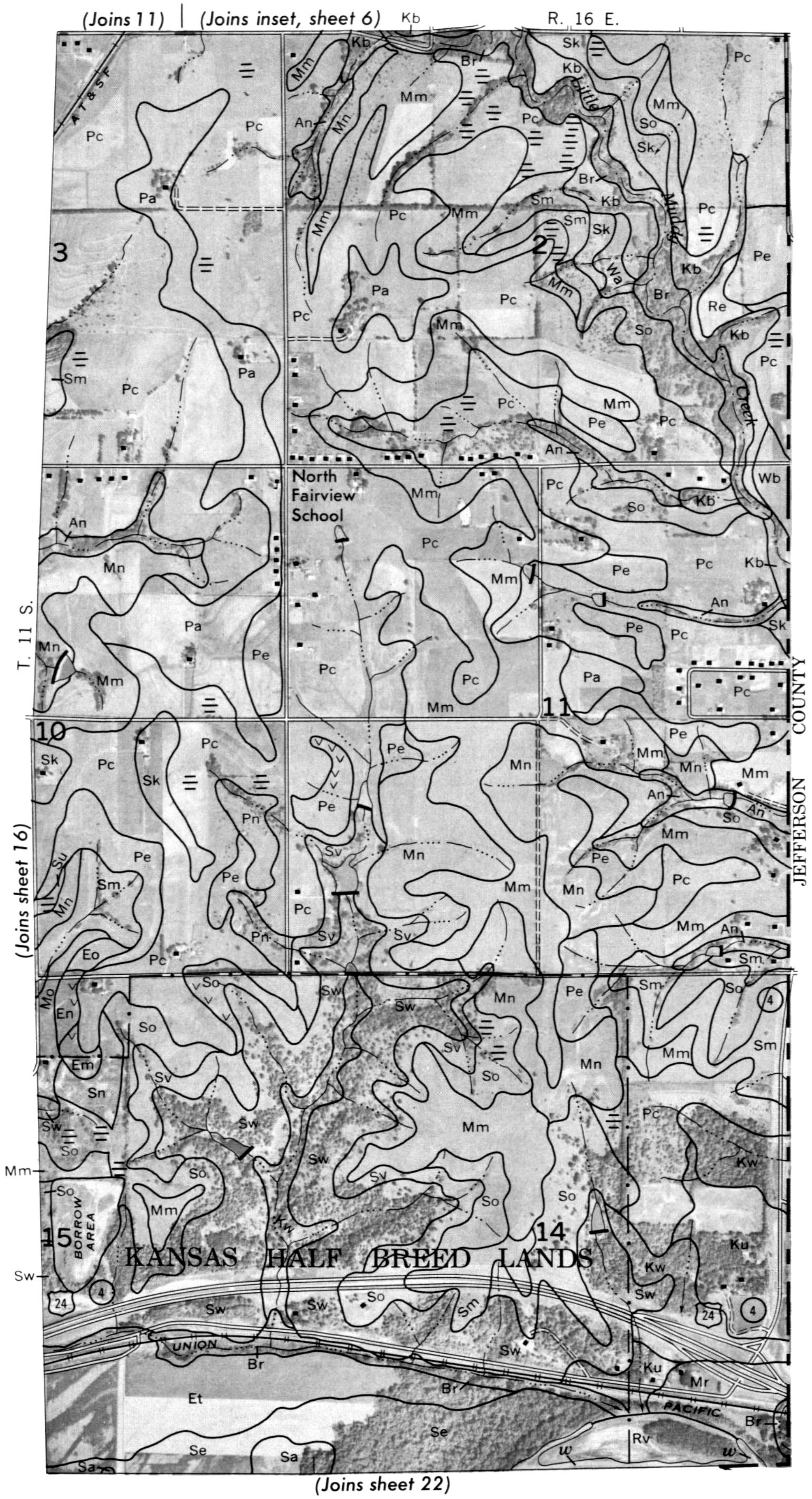
0 | 1000 | 2000 | 3000 | 4000 | 5000

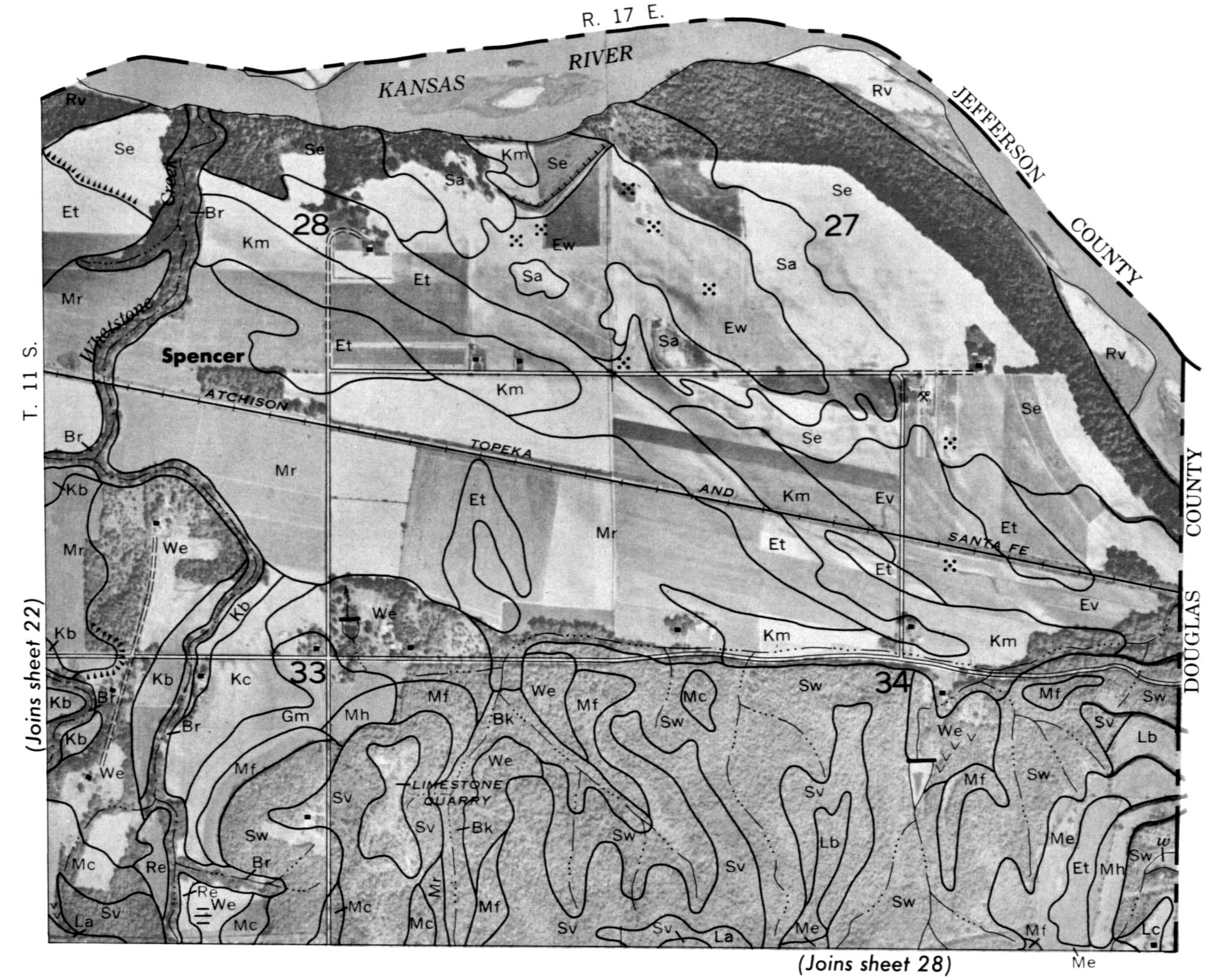
0 | ¼ | ½ | ¾ | 1

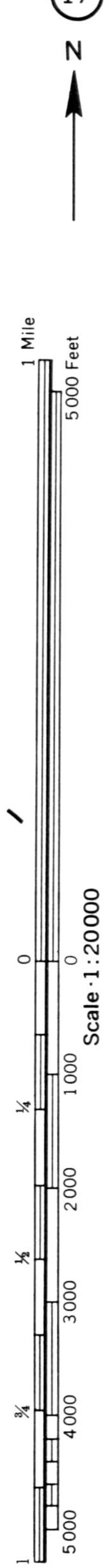
(Joins sheet 15)

(Joins sheet 17)

(Joins sheet 21)

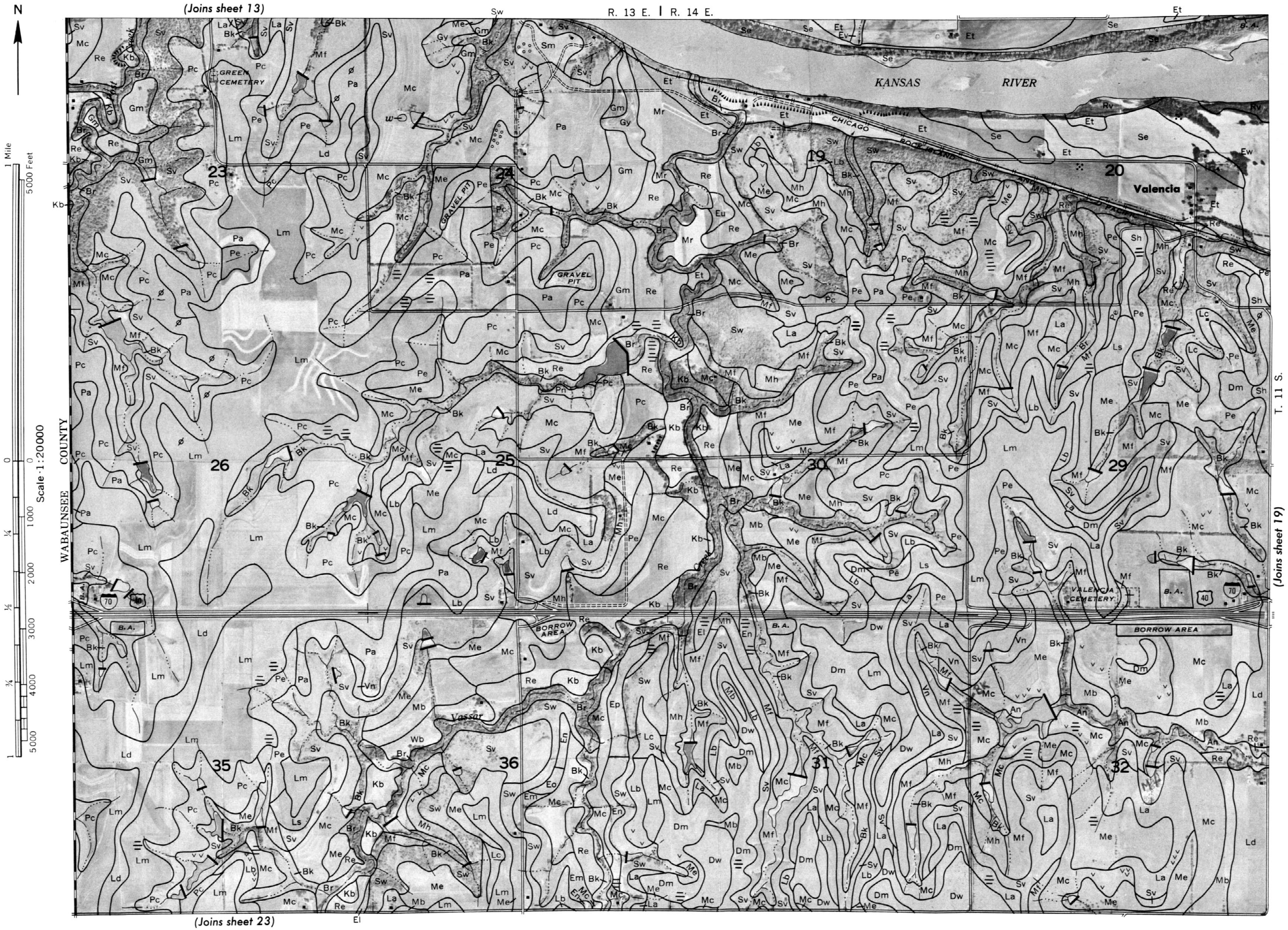


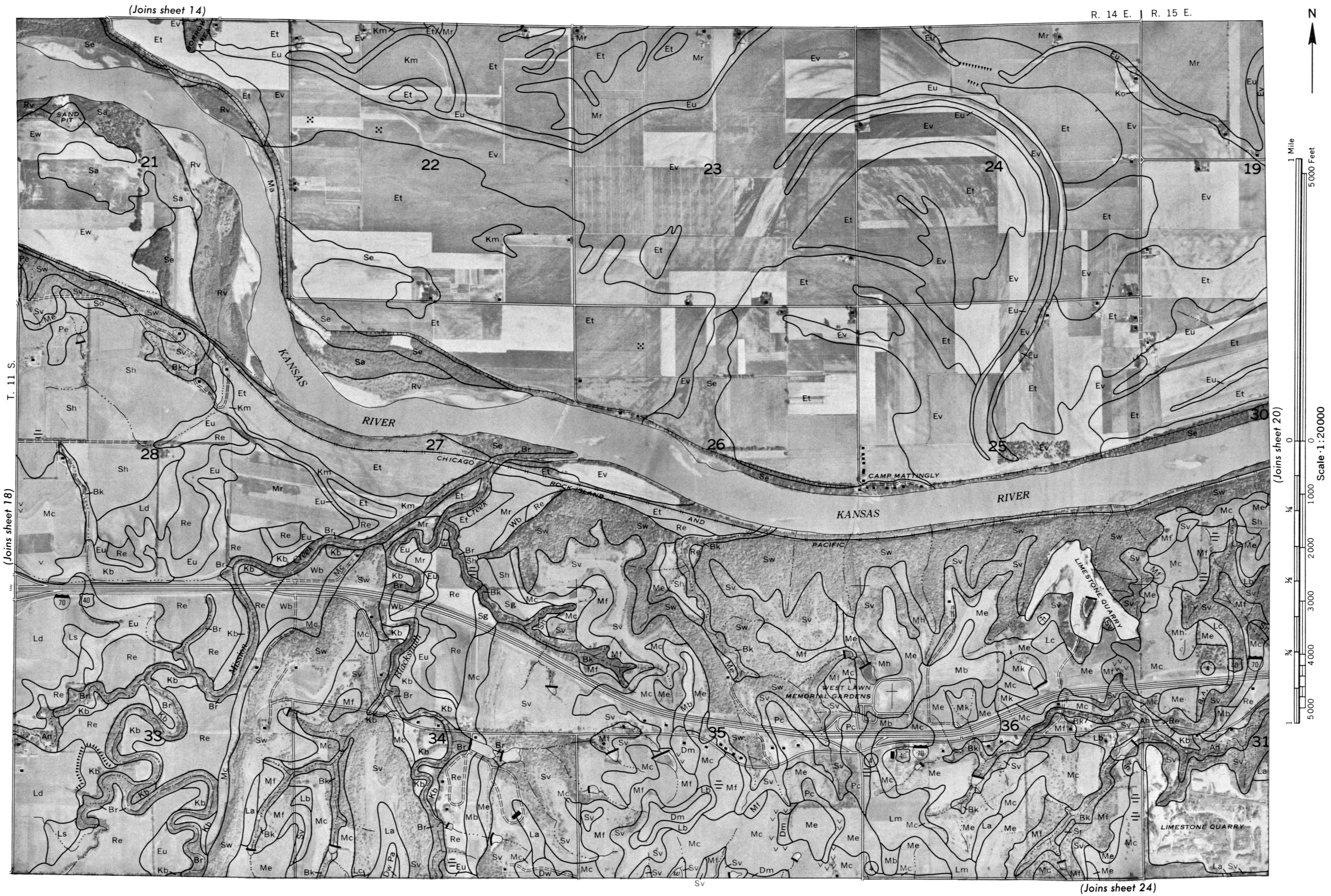




Land division corners are approximately positioned on this map.
SHAWNEE COUNTY, KANSAS NO. 17

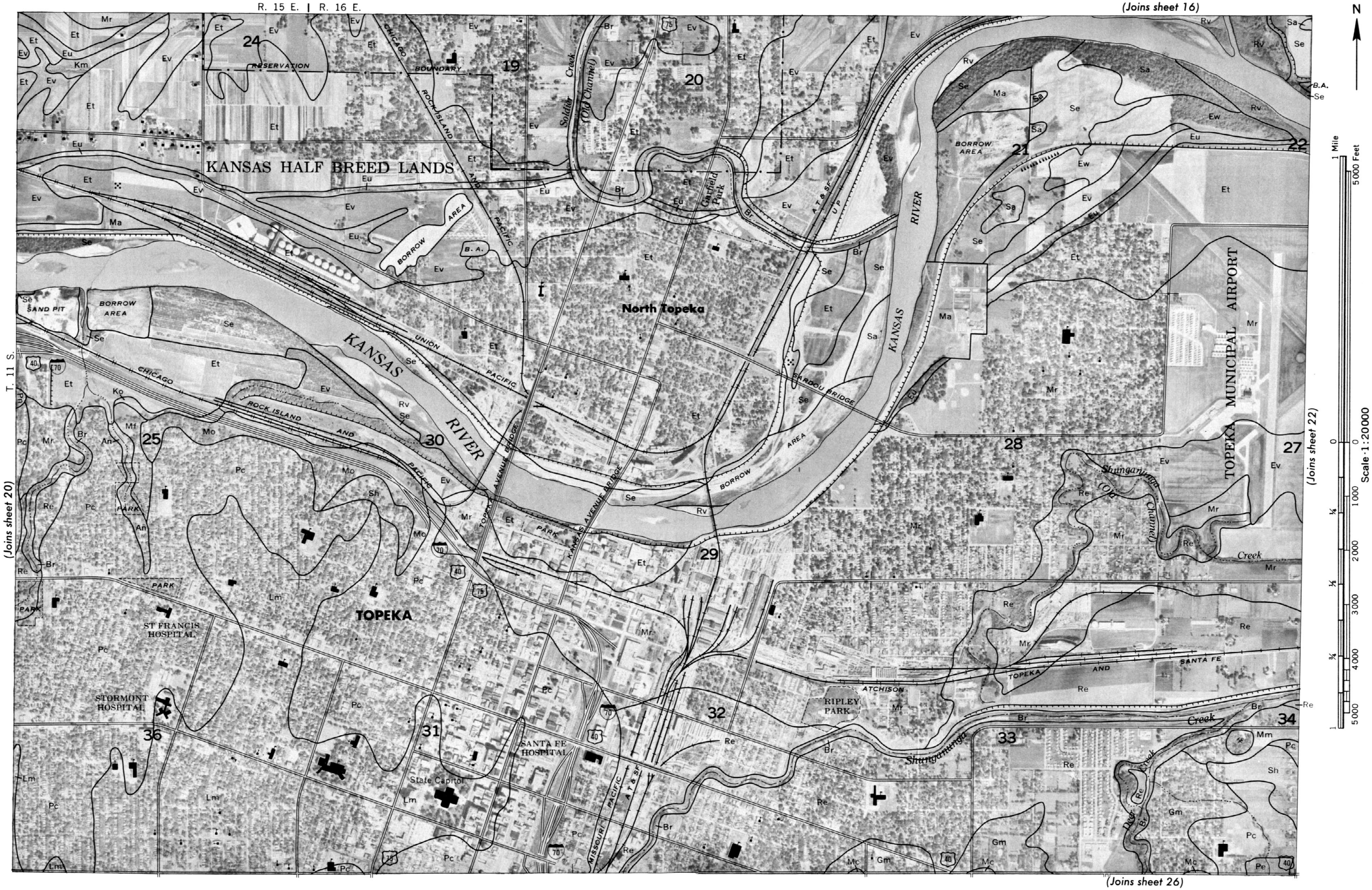
SHAWNEE COUNTY, KANSAS — SHEET NUMBER 18





Land division corners are approximately positioned on this map.
SHAWNEE COUNTY, KANSAS NO. 19


20
N
(Joins sheet 15)
R. 15 E.
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 25)
T. 11 S.
Scale 1:20000
1 Mile
5000 Feet
Radio Station
KANSAS HALF BREED LANDS
KANSAS RIVER
UNION PACIFIC
ROCK ISLAND
CHICAGO
BORROW AREA
Governor's Mansion
TV Transmitter
Hospital
LIMESTONE QUARRY
STATE HOSPITAL
MEMORIAL PARK CEMETERY
MT CALVARY CEMETERY
GAGE PARK
TOPEKA
PARK
Wanamaker School



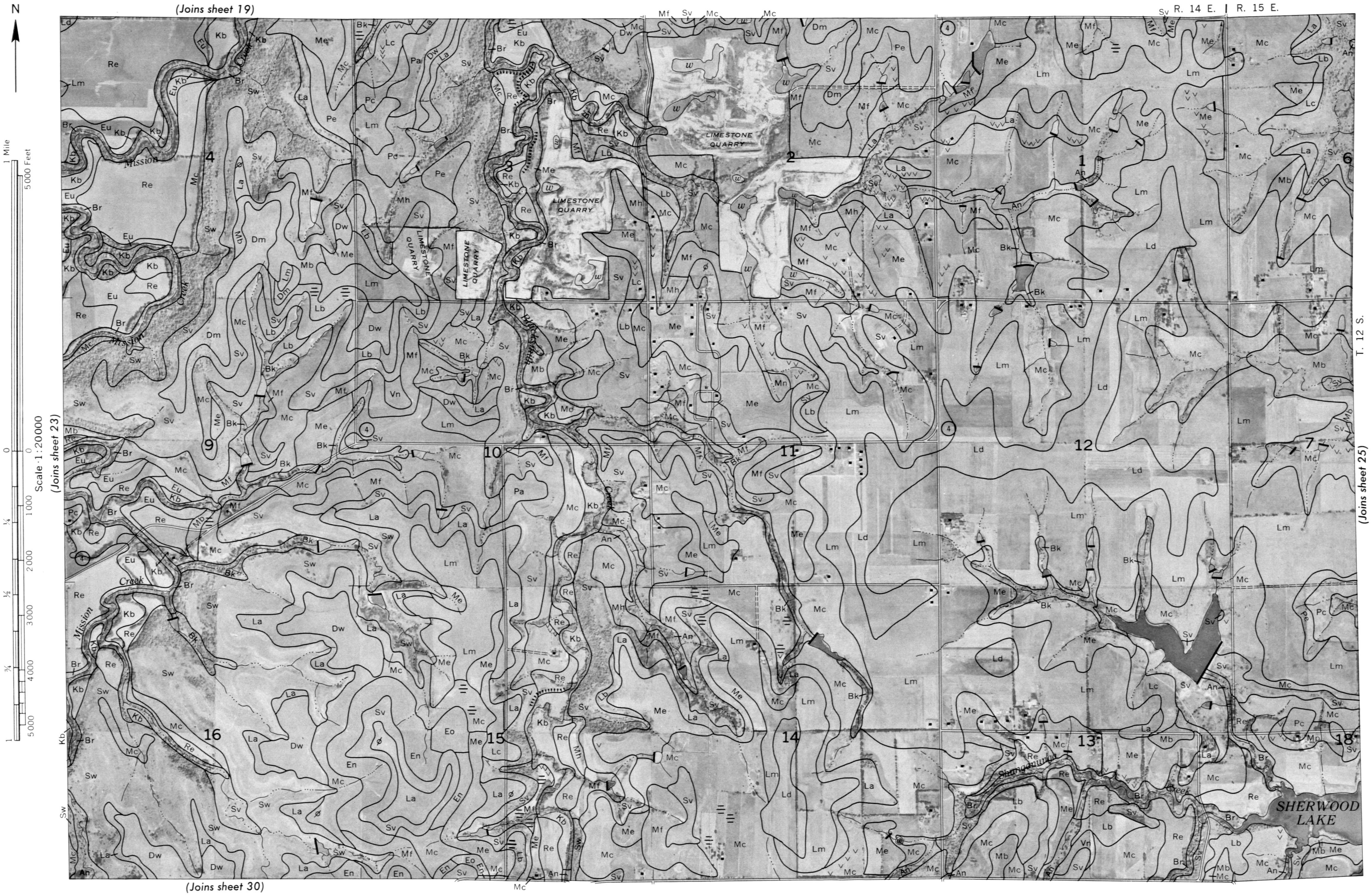
Land division corners are approximately positioned on this map.

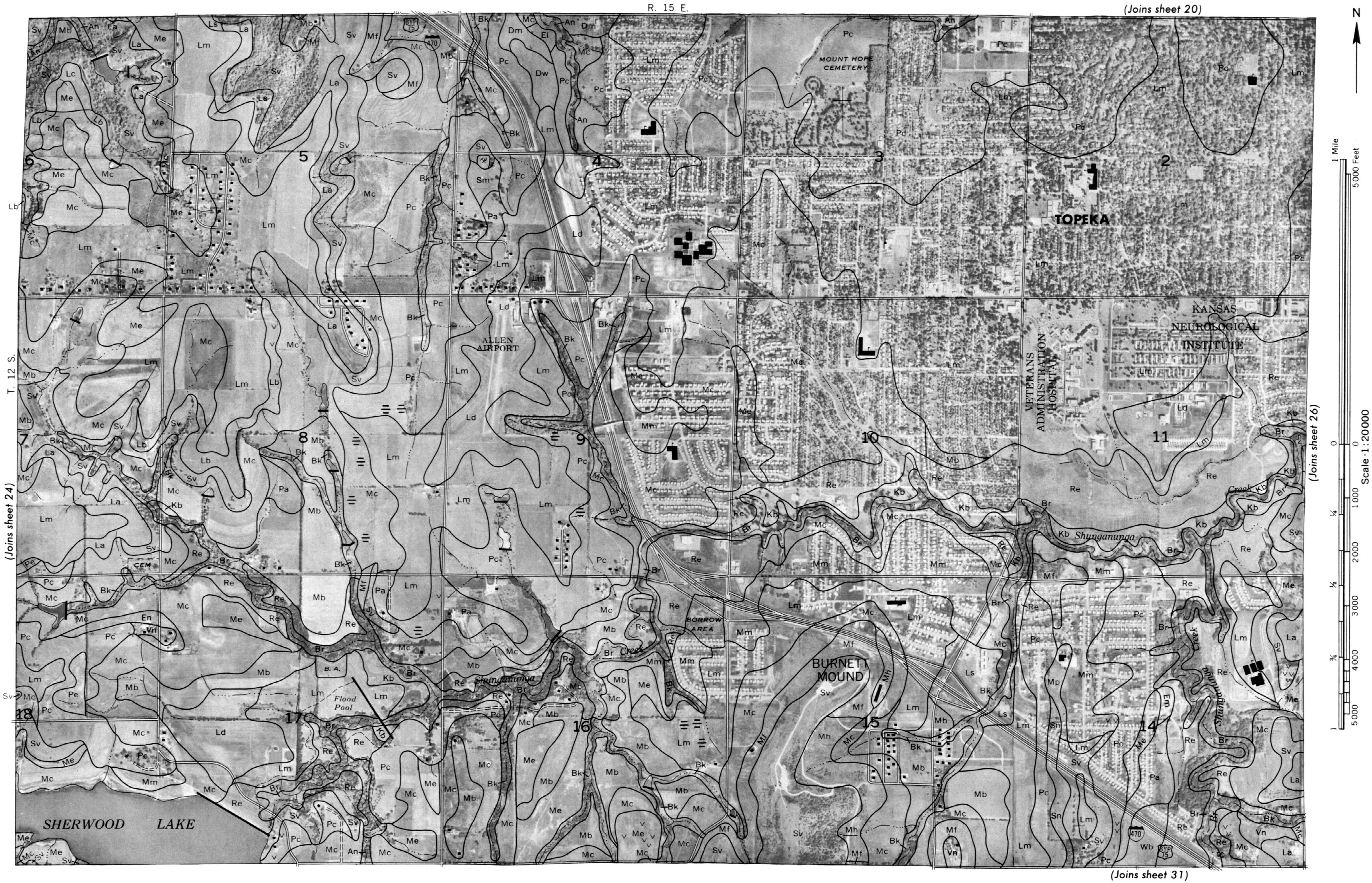
SHAWNEE COUNTY, KANSAS NO. 21


N
(Joins sheet 17)
(Joins sheet 21)
(Joins sheet 27)
(Joins inset, sheet 17)
1 Mile
5000 Feet
Scale 1:20000
KANSAS HALF BREED LANDS
BORROW AREA
KANSAS RIVER
TOPEKA MUNICIPAL AIRPORT
Shunganunga Creek
(Old Channel)
SAND PIT
water
JEFFERSON COUNTY
KANSAS RIVER
R. 16 E. | R. 17 E.
SANTA FE
ATCHISON TOPEKA AND
INDUSTRIAL SITE
TECUMSEH
Tecumseh Elem Sch
Stinson Creek
Tecumseh Creek
Whetstone Creek
T. 11 S.
40
22
23
25
26
27
29
30
31
32
34
35
36

Land division corners are approximately positioned on this map.

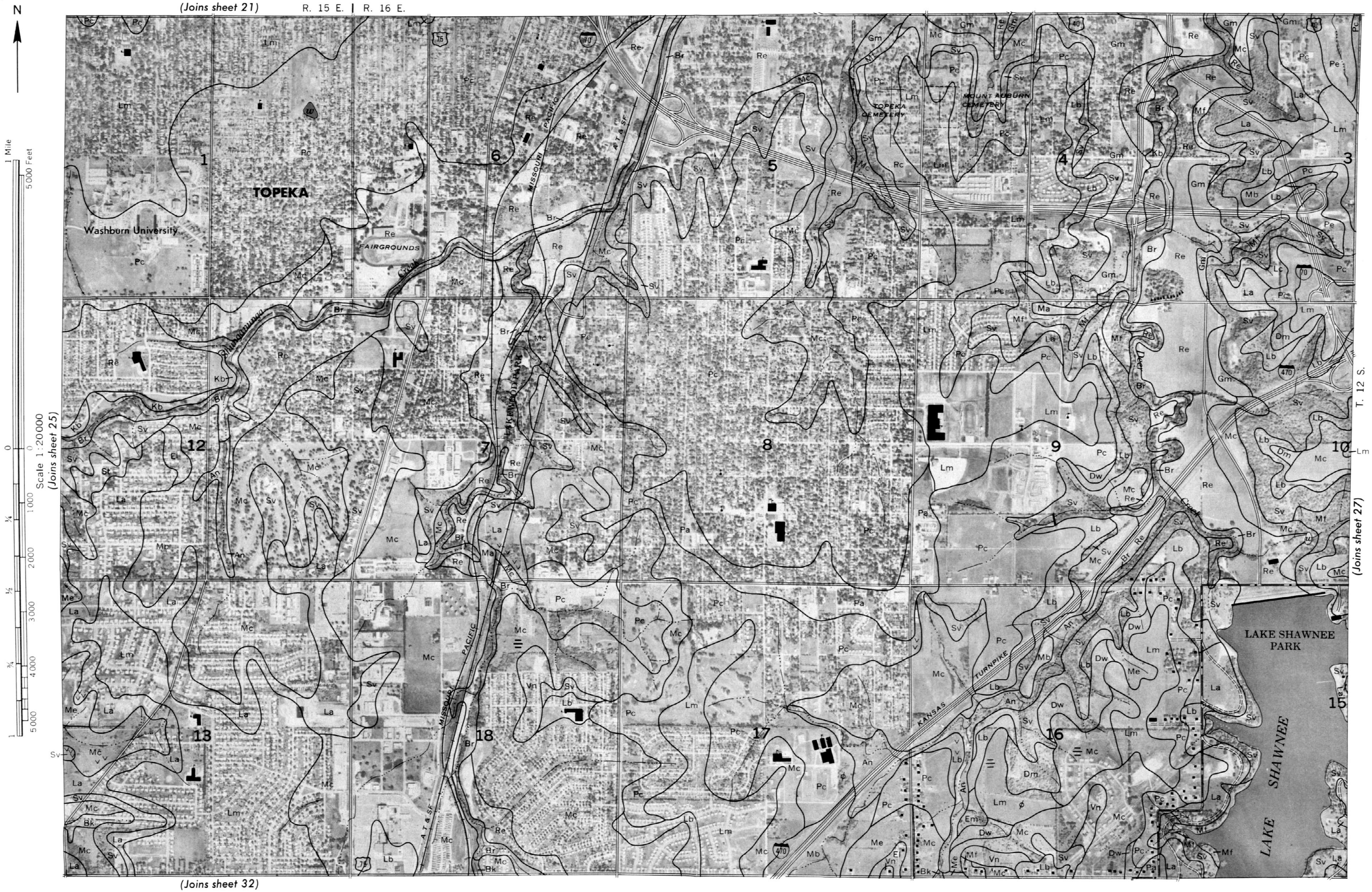
SHAWNEE COUNTY, KANSAS NO. 23

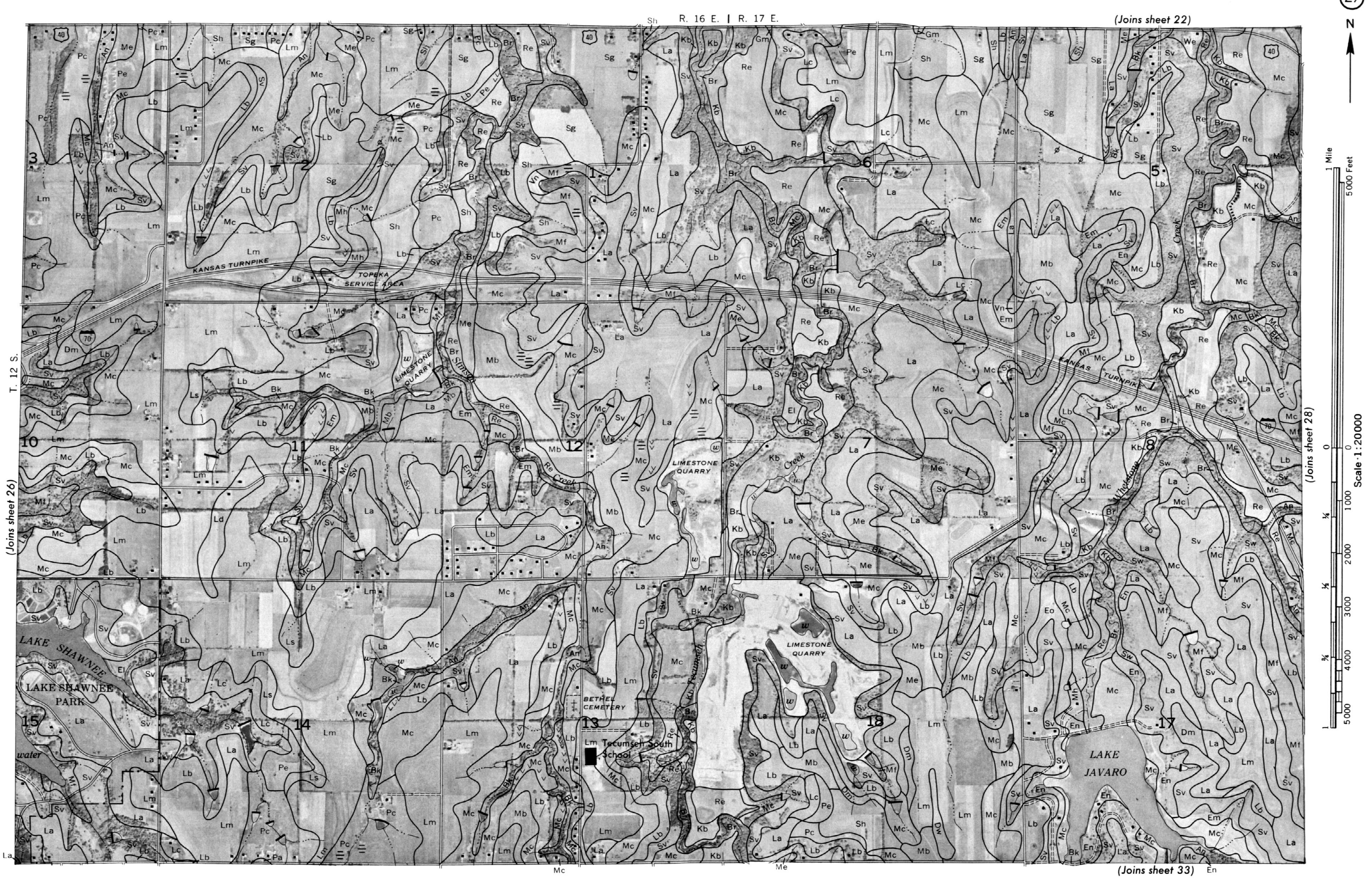

N
(Joins sheet 19)
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 30)
R. 14 E.
R. 15 E.
T. 12 S.
Scale 1:20000
1 Mile
5000 Feet
LIMESTONE QUARRY
LIMESTONE QUARRY
LIMESTONE QUARRY
LIMESTONE QUARRY
Mission Creek
Shunganunga Creek
SHERWOOD LAKE



Land division corners are approximately positioned on this map.
SHAWNEE COUNTY, KANSAS NO. 25

SHAWNEE COUNTY, KANSAS — SHEET NUMBER 26





Land division corners are approximately positioned on this map.

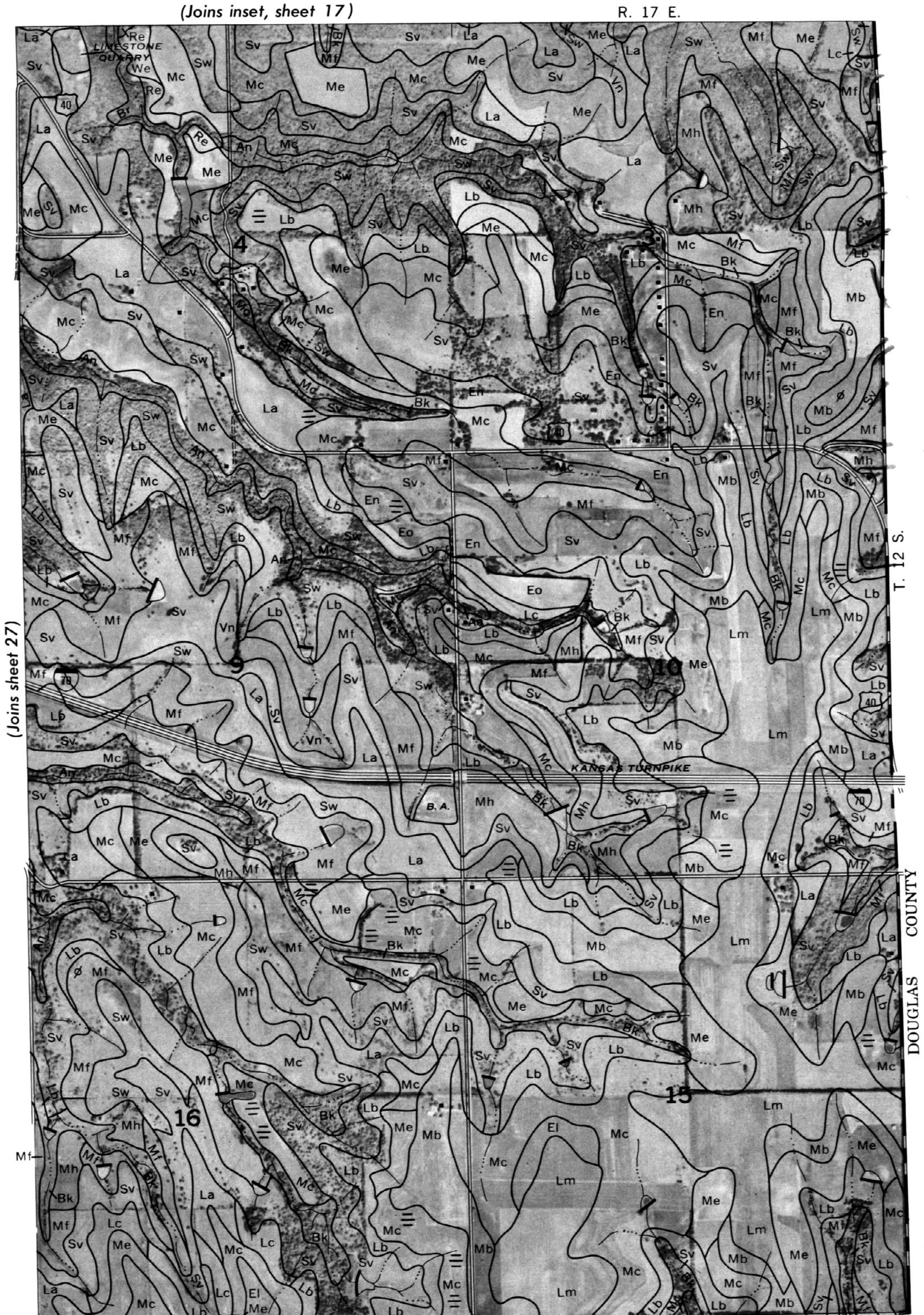
SHAWNEE COUNTY, KANSAS NO. 27

N

Scale 1:20000

1 Mile
5000 Feet

(Joins inset, sheet 17)



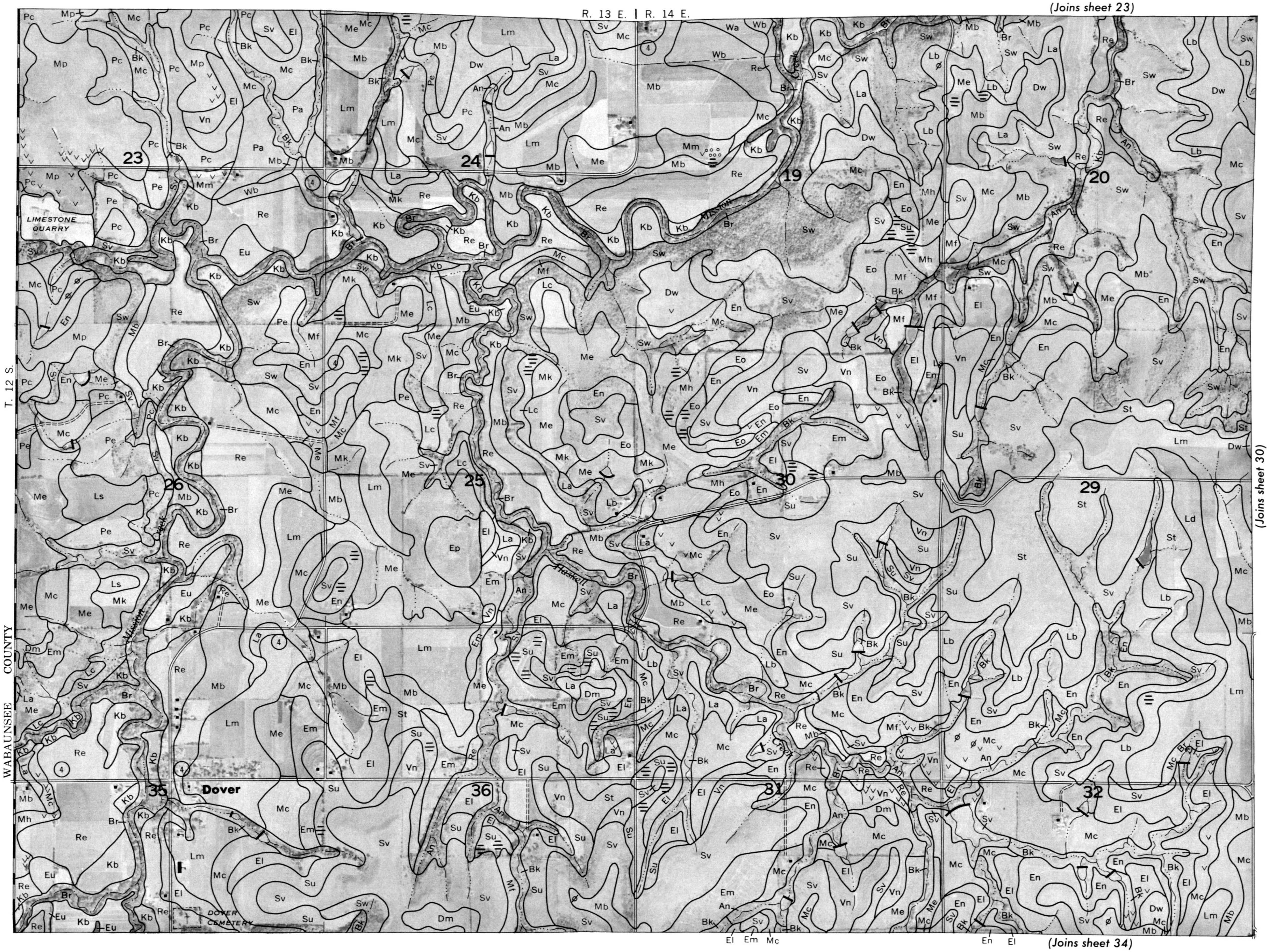
(Joins sheet 27)

(Joins upper right)

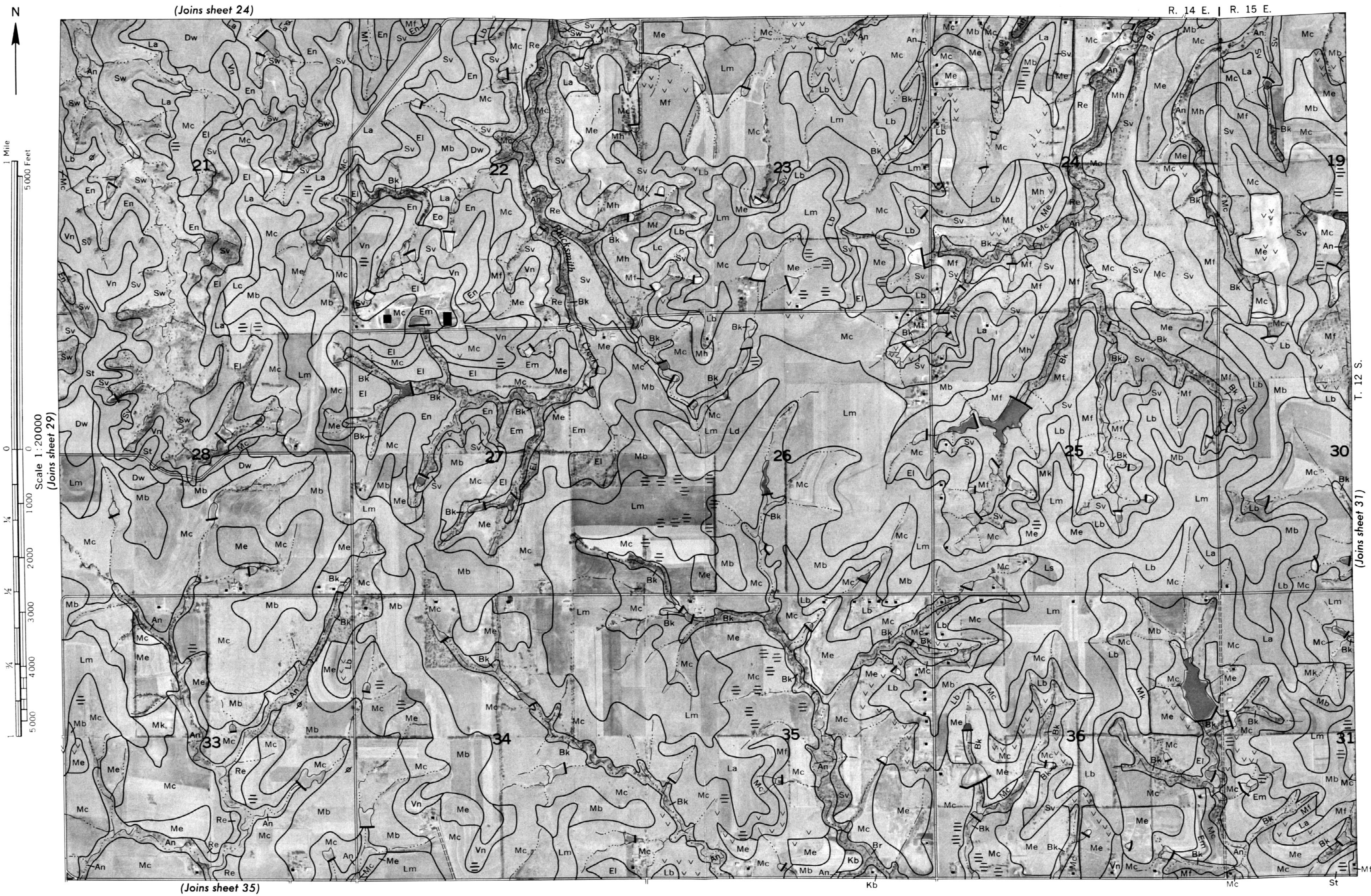
(Joins lower left)

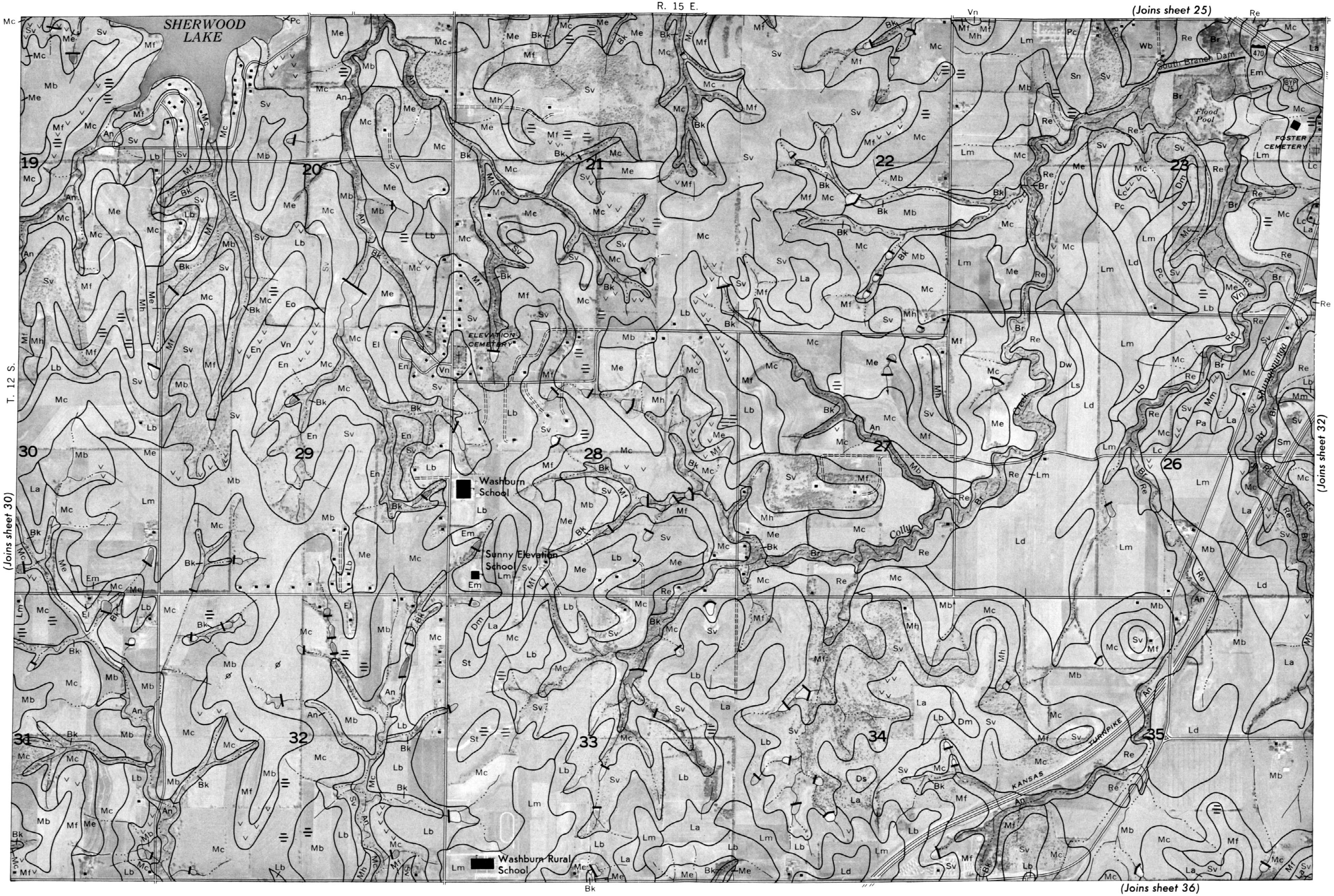
(Joins sheet 33)

(Joins sheet 39)



Land division corners are approximately positioned on this map.
SHAWNEE COUNTY, KANSAS NO. 29


N
(Joins sheet 24)
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 35)
R. 14 E. | R. 15 E.
T. 12 S.
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
Buckeye Creek



N

1 Mile

5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000

Land division corners are approximately positioned on this map.

SHAWNEE COUNTY, KANSAS NO. 31

N

(Joins sheet 26)

R. 15 E. | R. 16 E.

1 Mile

5000 Feet

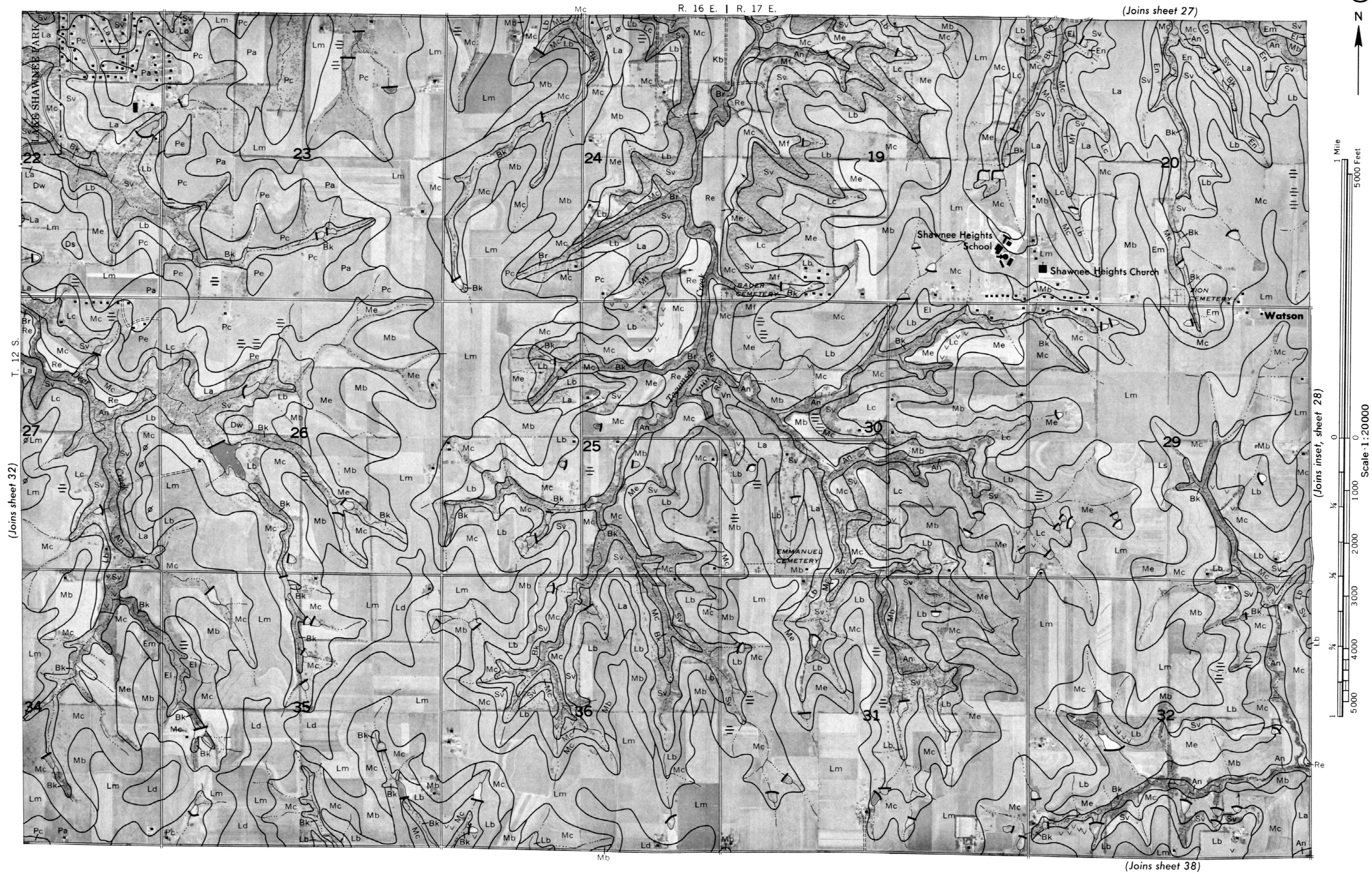
Scale 1:20000

(Joins sheet 31)

T. 12 S.

(Joins sheet 33)

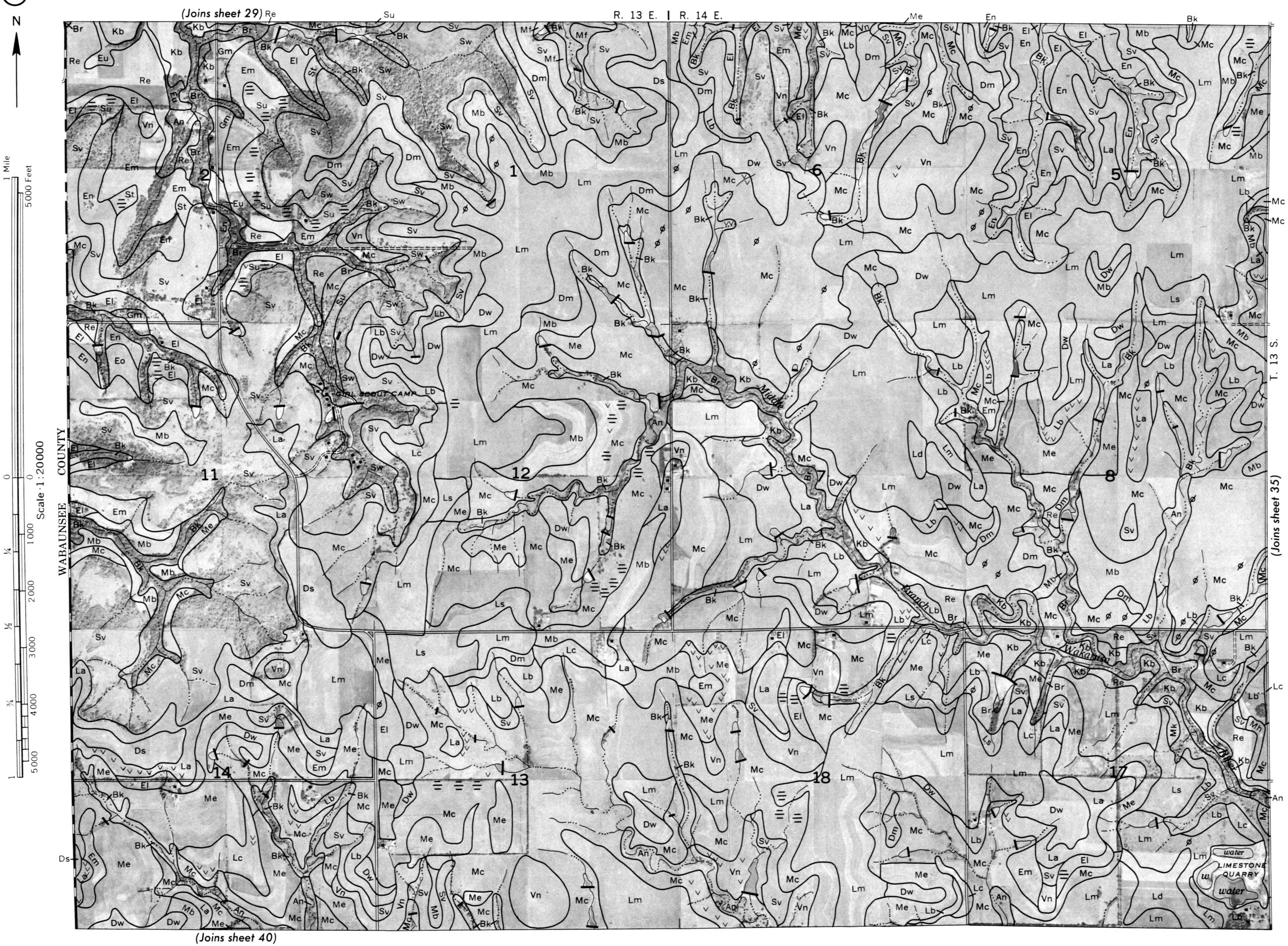
(Joins sheet 37)

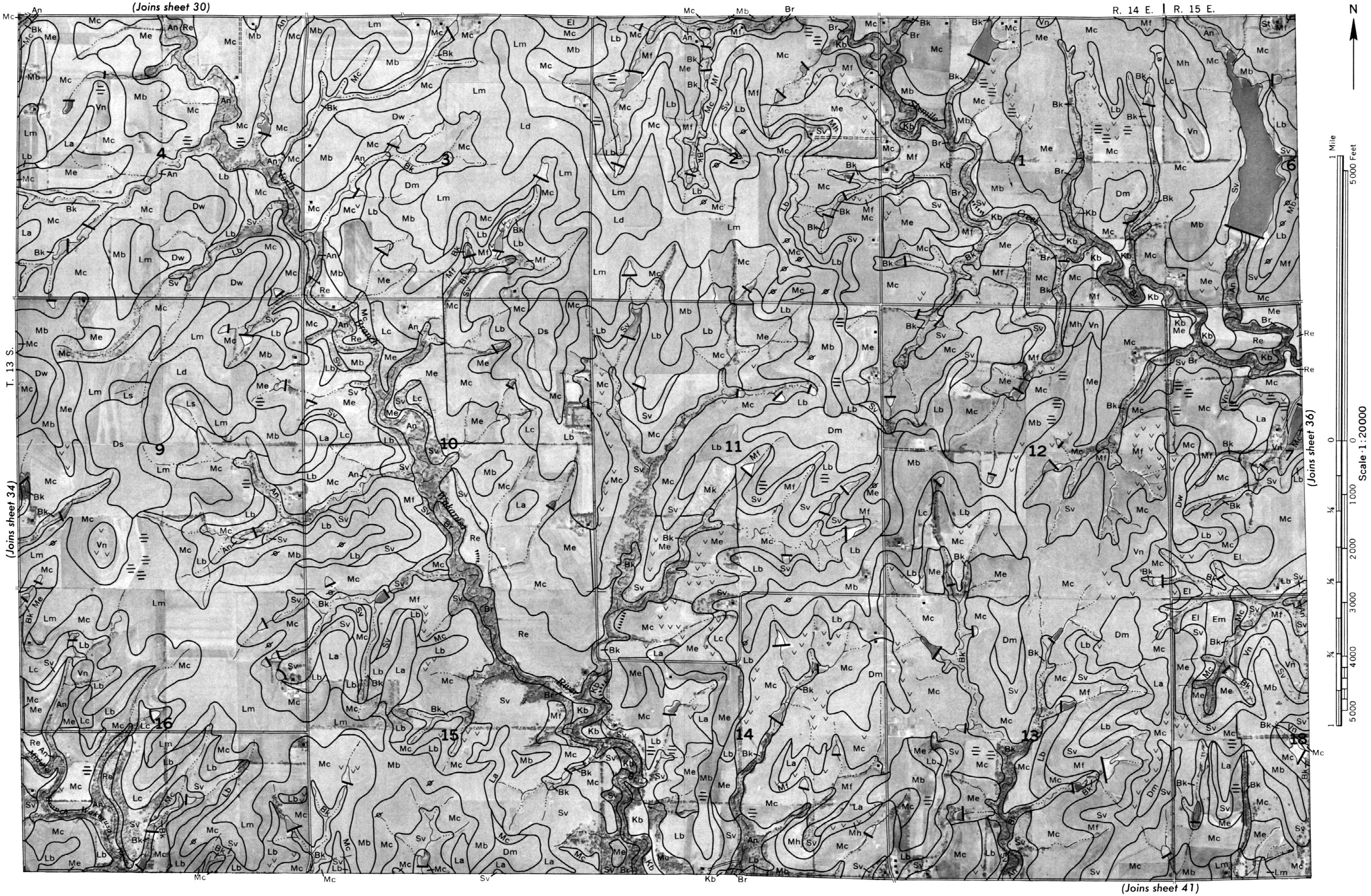


Land division corners are approximately positioned on this map.

SHAWNEE COUNTY, KANSAS NO. 33

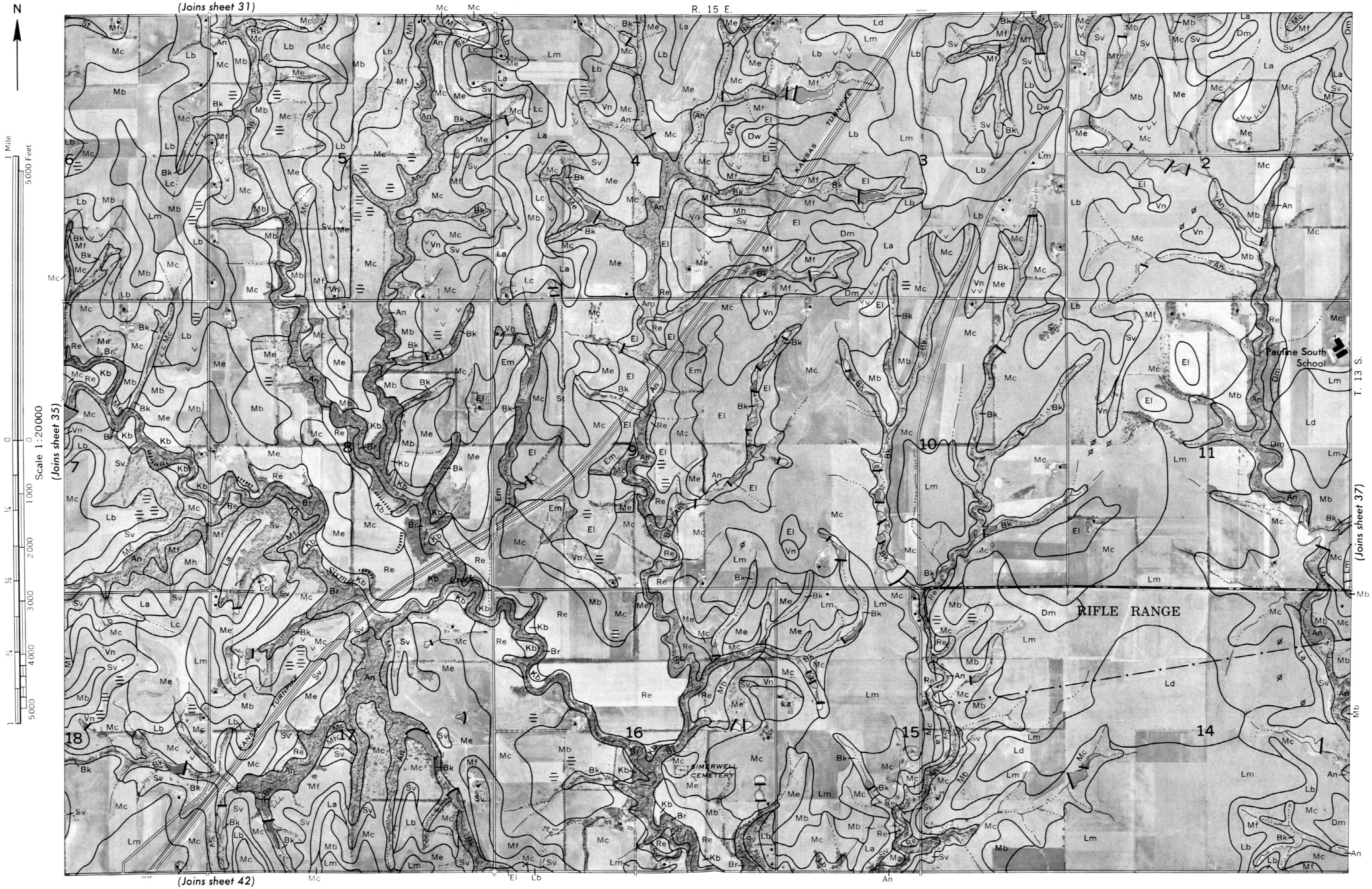
SHAWNEE COUNTY, KANSAS — SHEET NUMBER 34





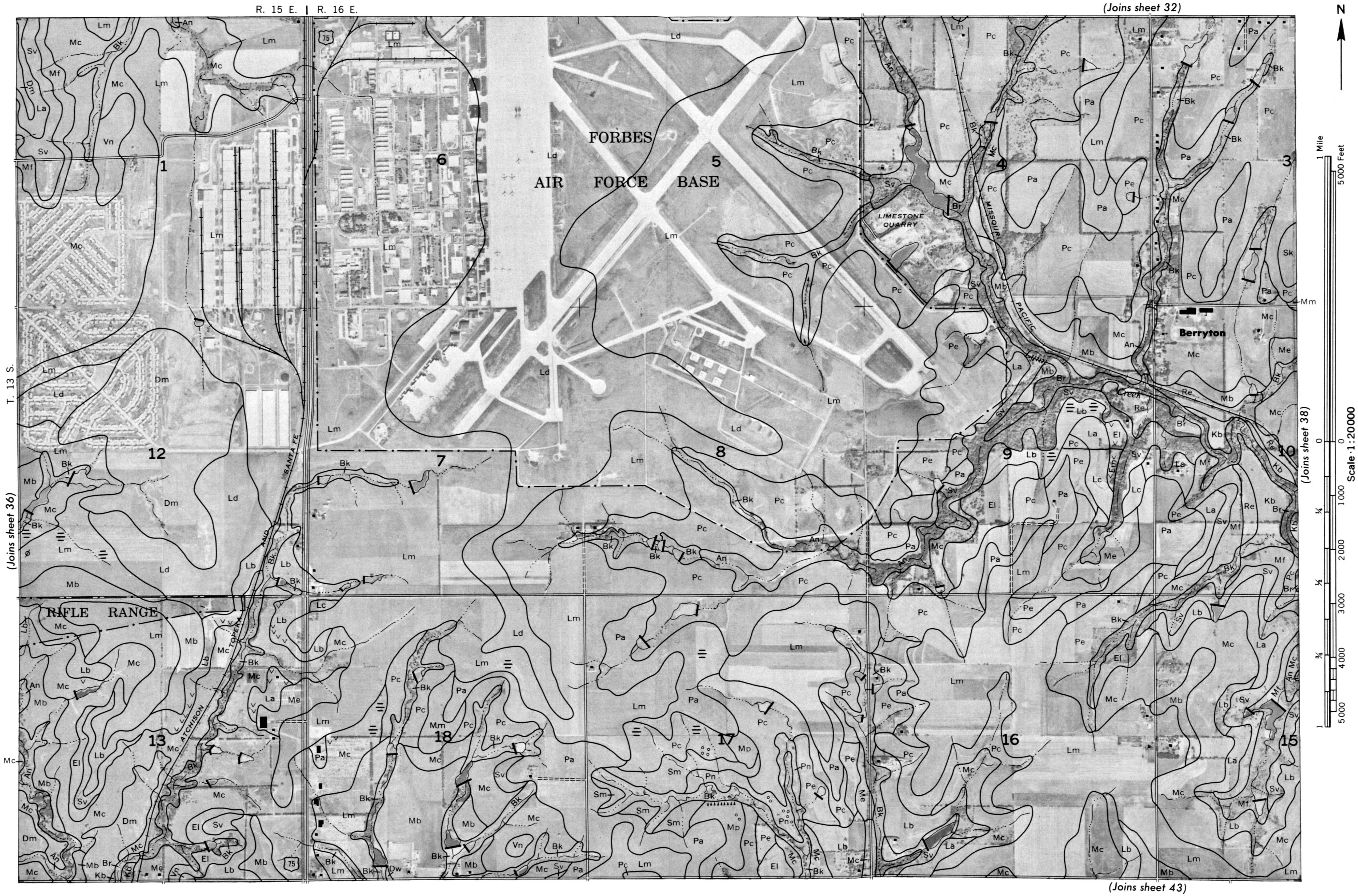
Land division corners are approximately positioned on this map.

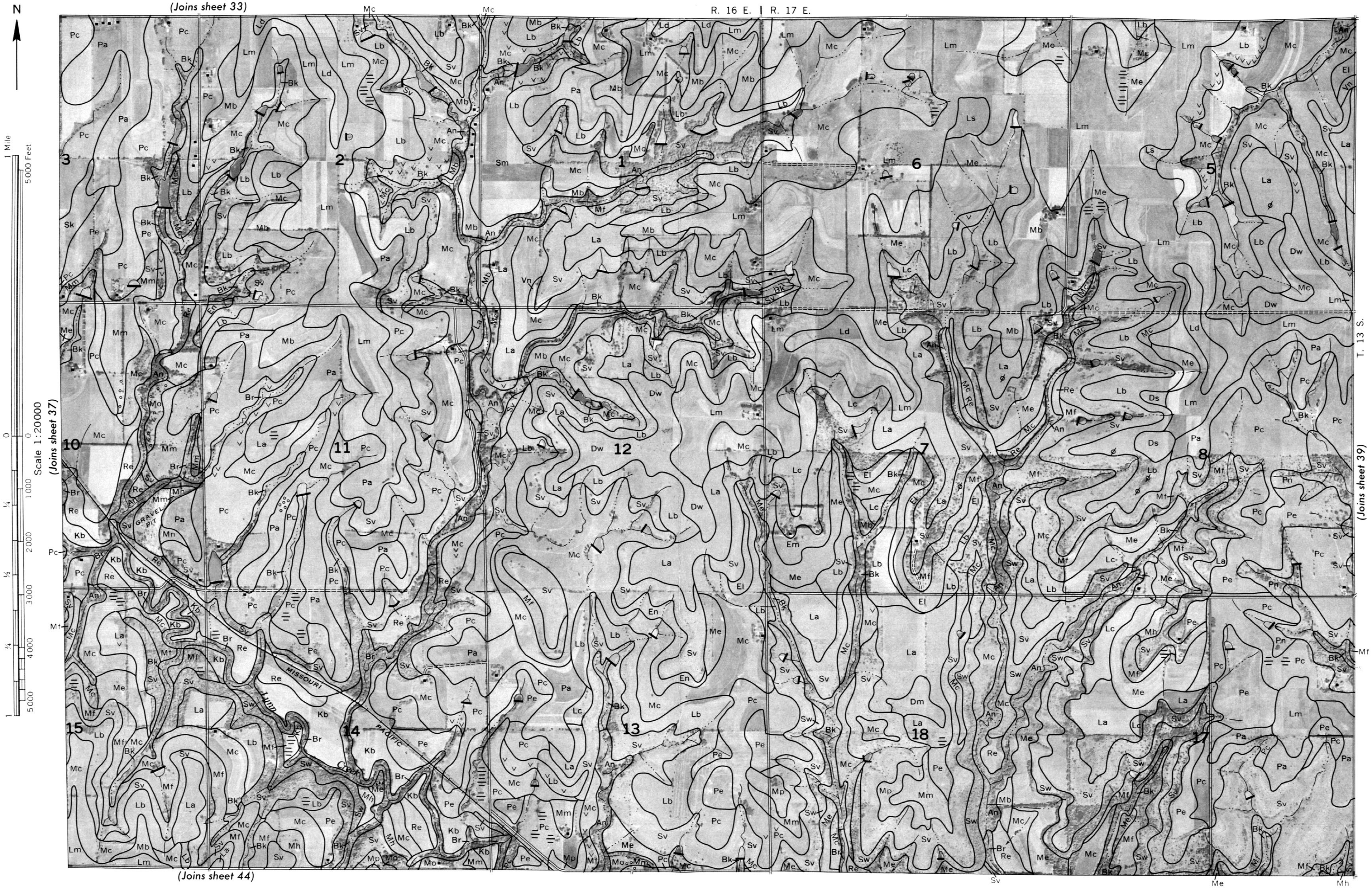
SHAWNEE COUNTY, KANSAS NO. 35


(Joins sheet 31)
R. 15 E.
T. 13 S.
(Joins sheet 35)
(Joins sheet 37)
(Joins sheet 42)
N
1 Mile
5000 Feet
Scale 1:20000
KANSAS TURNPIKE
RIFLE RANGE
Pauline South School
SIMERWELL CEMETERY

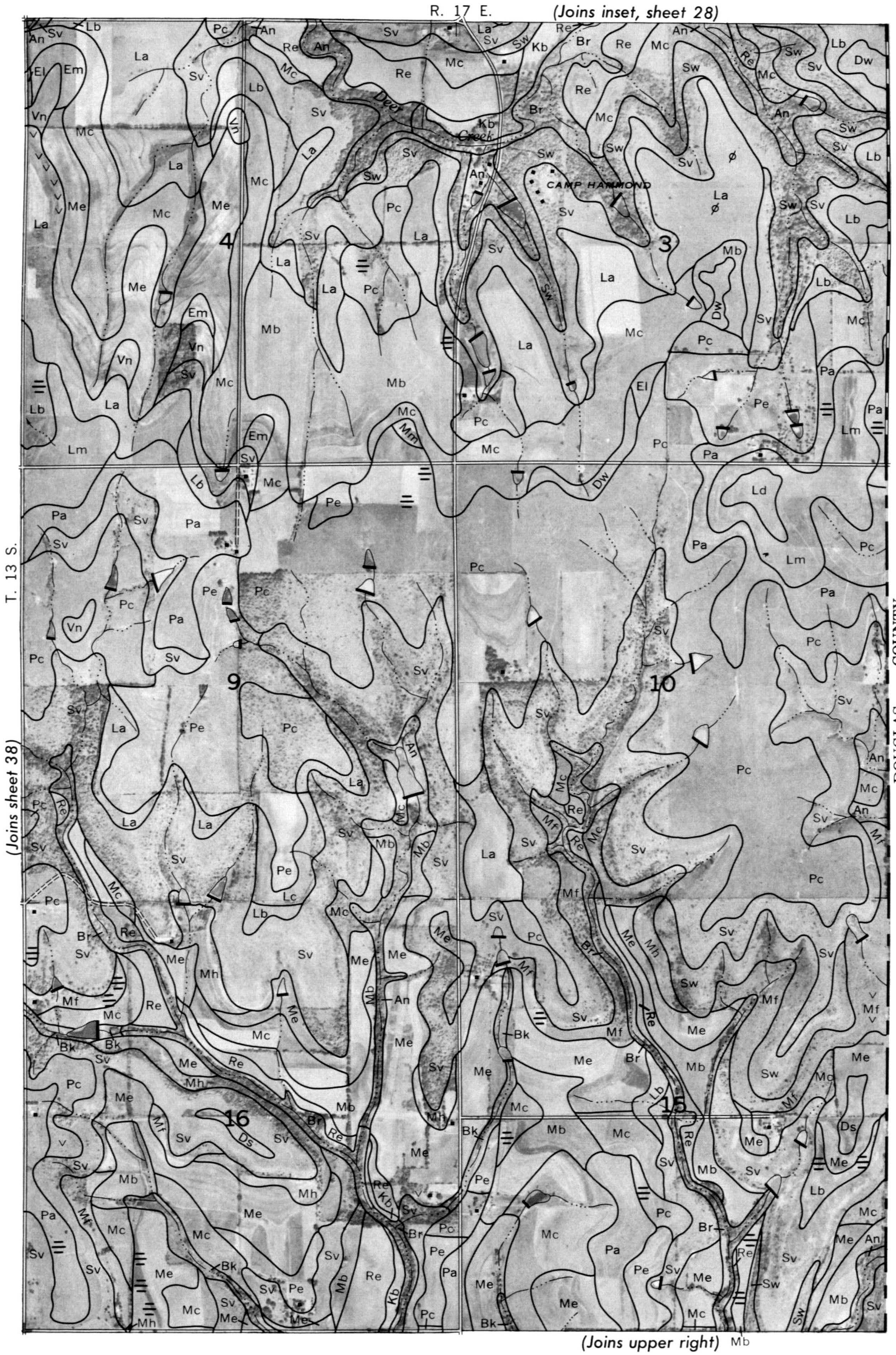
Land division corners are approximately positioned on this map.

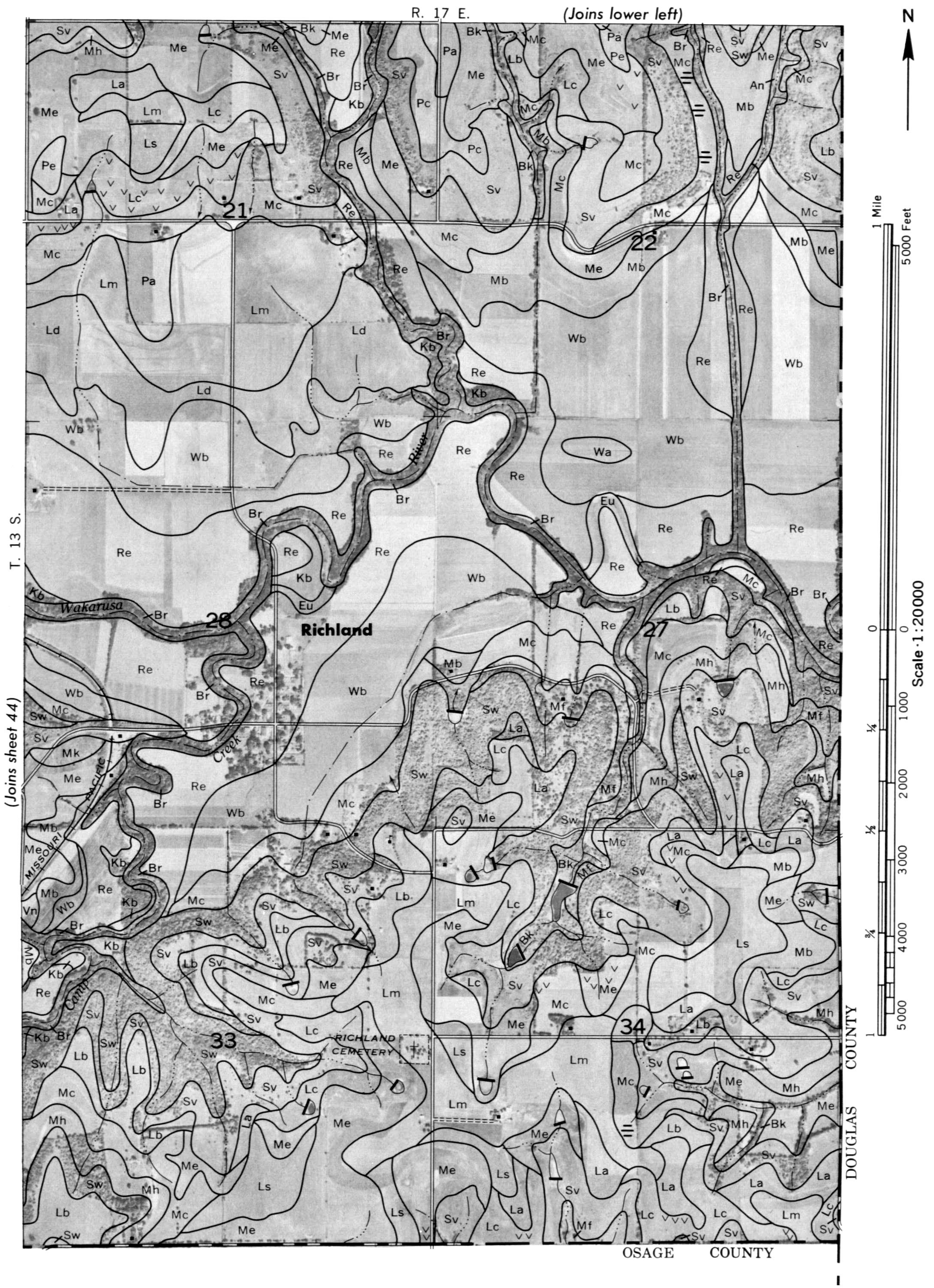
SHAWNEE COUNTY, KANSAS NO. 37

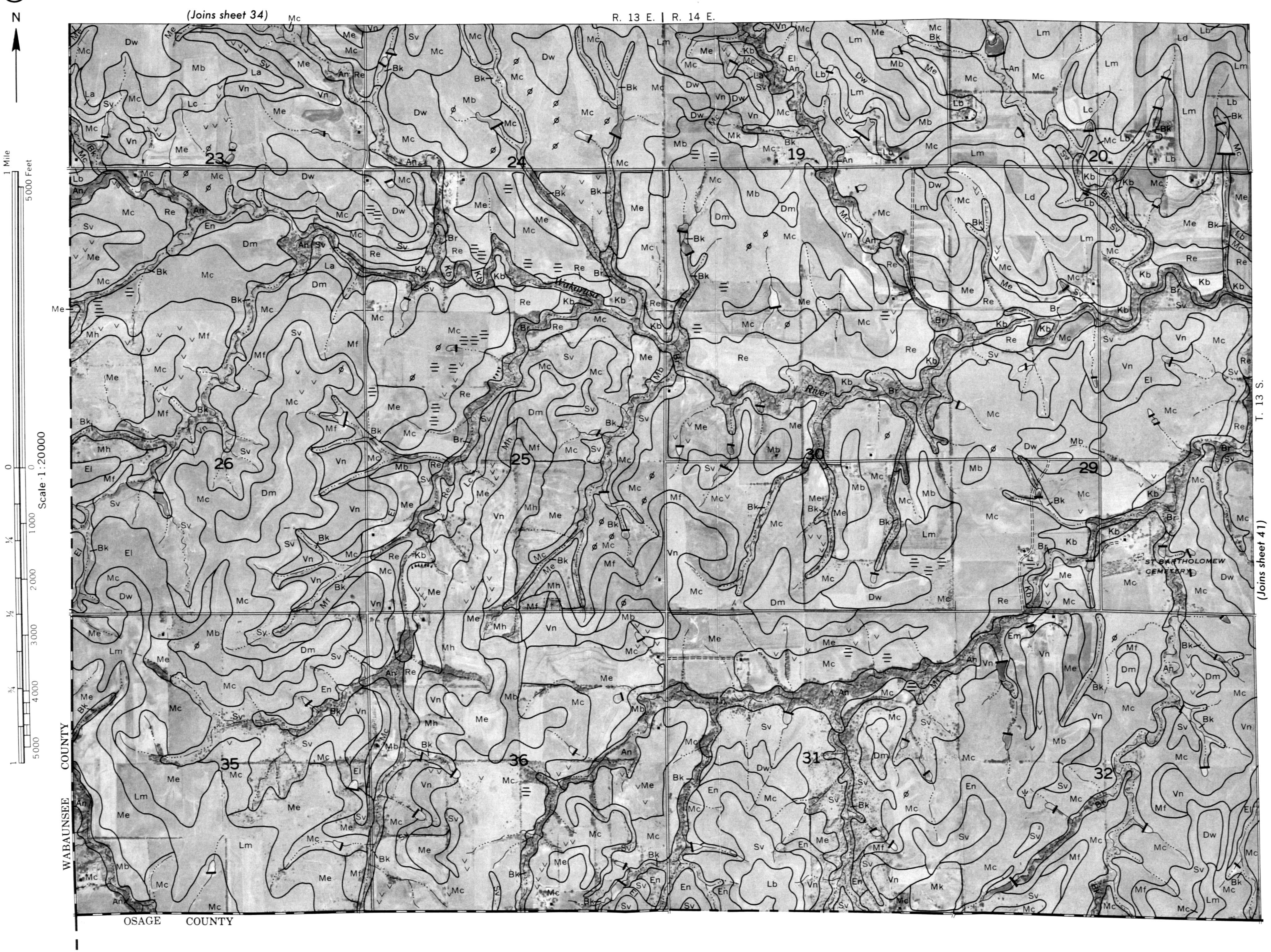


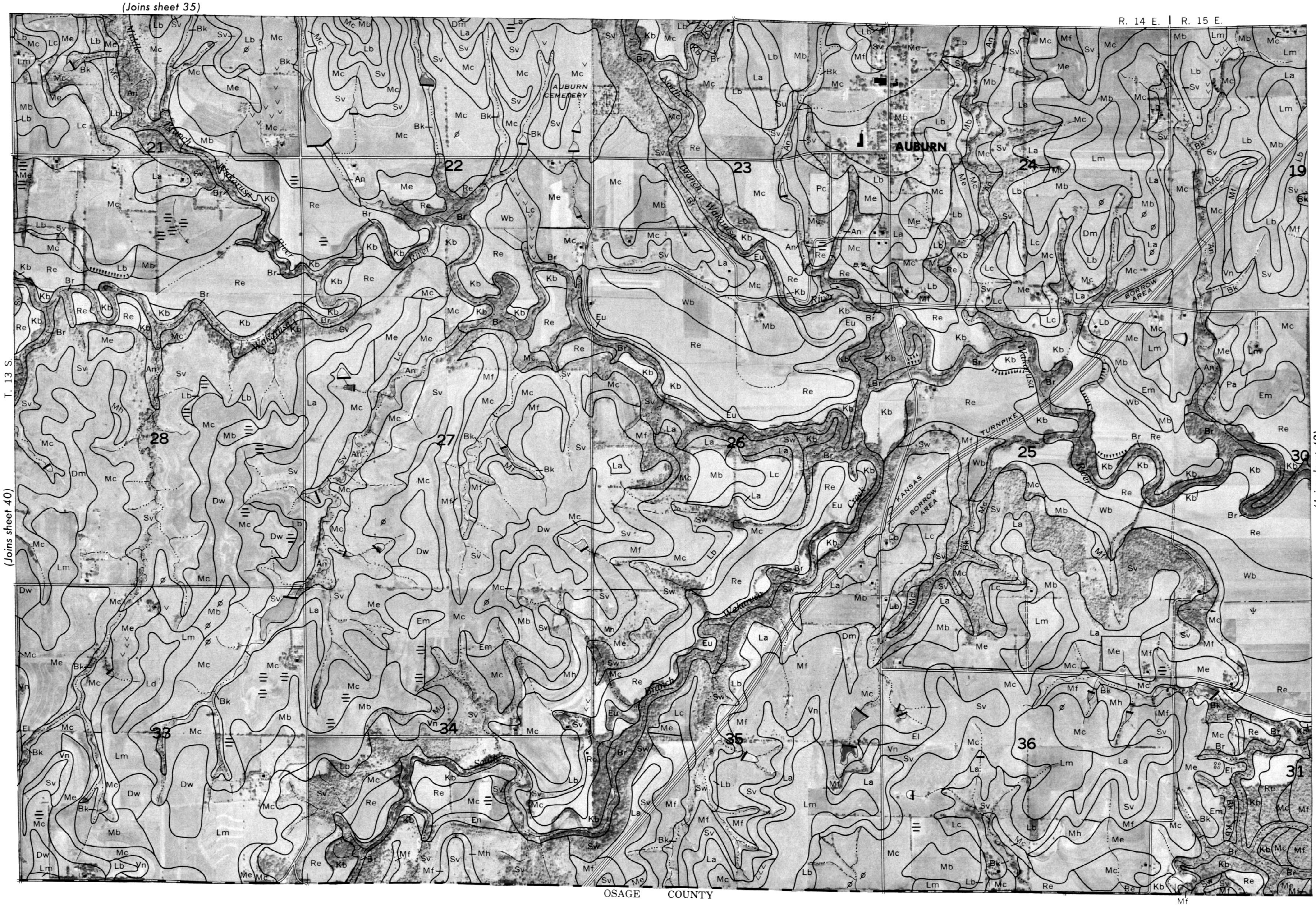

38
N
(Joins sheet 33)
R. 16 E. | R. 17 E.
T. 13 S.
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 44)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
GRAVEL PIT
MISSOURI PACIFIC
Lynn Creek

Land division corners are approximately positioned on this map.
SHAWNEE COUNTY, KANSAS NO. 39






N
(Joins sheet 34)
R. 13 E. | R. 14 E.
T. 13 S.
(Joins sheet 41)
Wakarusa
River
ST BARTHOLOMEW CEMETERY
23
24
19
20
26
25
30
29
35
36
31
32
WABAUNSEE COUNTY
OSAGE COUNTY
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1



N

1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1

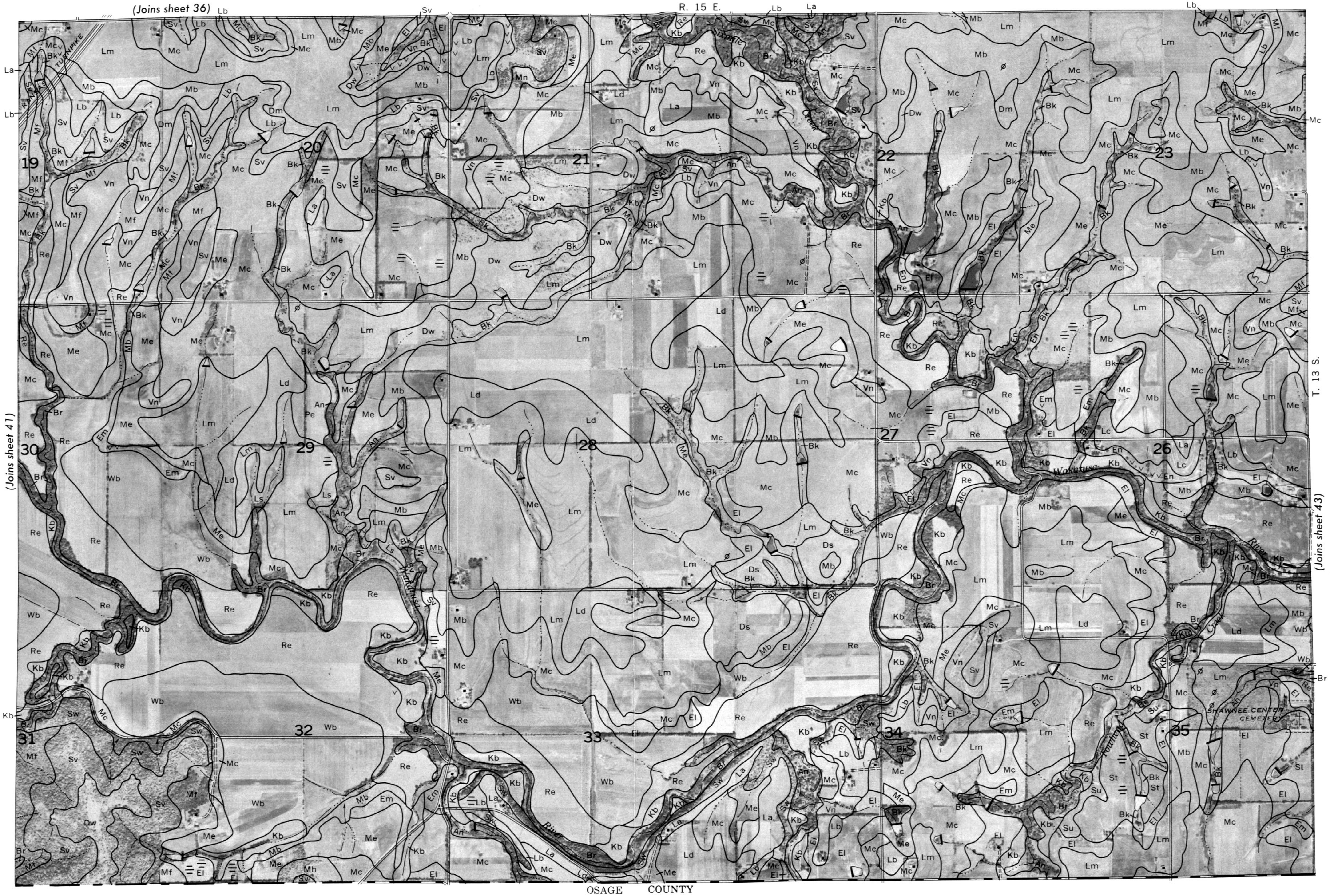
Land division corners are approximately positioned on this map

SHAWNEE COUNTY, KANSAS NO. 41

42

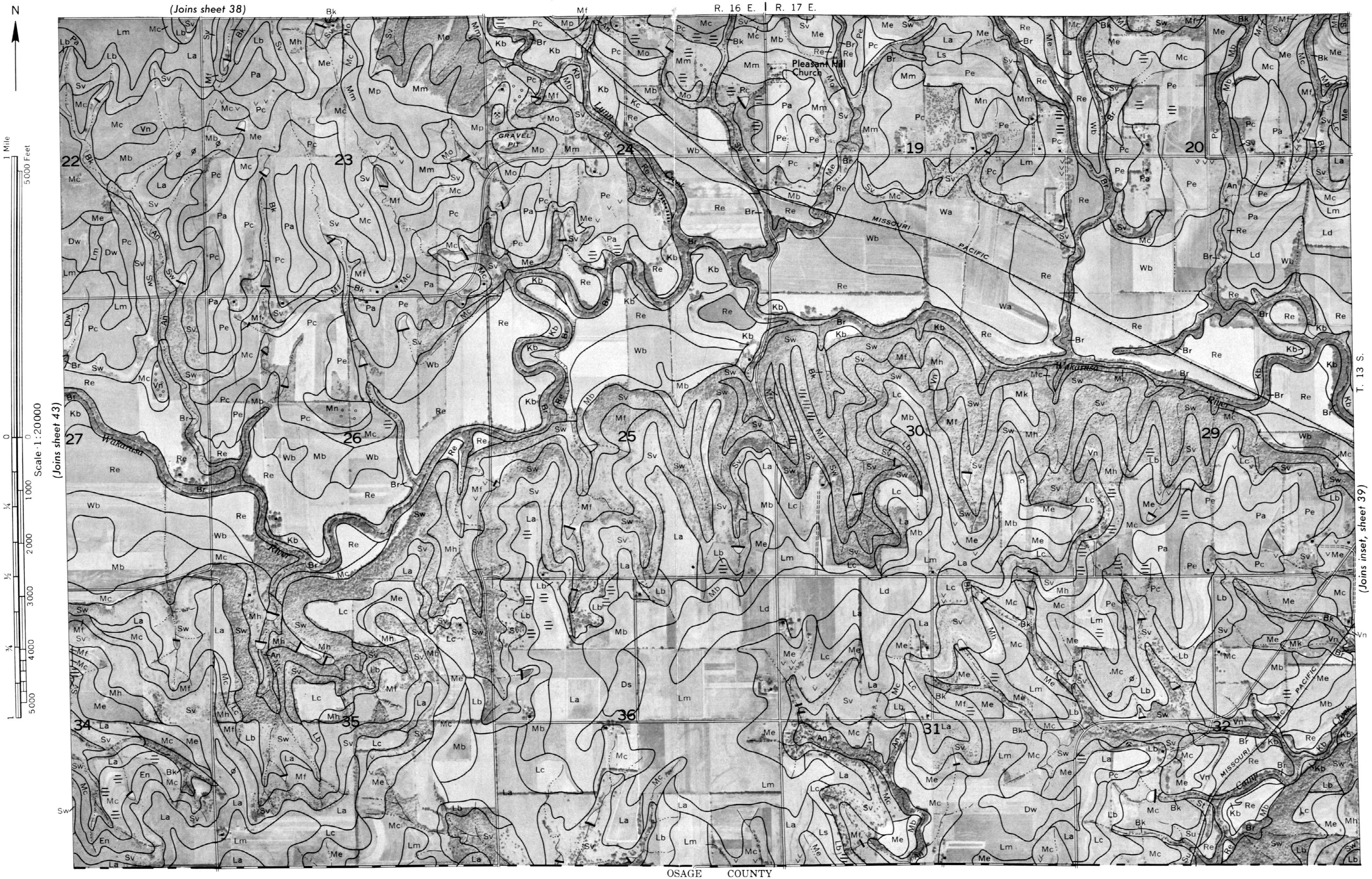
N

1 Mile
5000 Feet
Scale 1:20000



Land division corners are approximately positioned on this map.

SHAWNEE COUNTY, KANSAS NO. 43



SHAWNEE COUNTY, KANSAS NO. 44